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PORT EVERGLADES BROWARD COUNTY, FLORIDA ENVIRONMENTAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, DEPARTMENT OF DEFENSE

TRANSMITTING

THE DEPARTMENT'S PORT EVERGLADES FINAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT DATED MAY 2015

PART 2 OF 3

FEBRUARY 25, 2016.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

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EIS
SUB-APPENDIX A

PERTINENT CORRESPONDENCE

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

ER 13/0465
9043.1

August 13, 2013

Ms. Terri Jordan-Sellers
U.S. Army Corps of Engineers
701 San Marco Boulevard
Jacksonville, FL 32207

Re: Comments on the Draft Environmental Impact Statement (DEIS) for Port Everglades Harbor Navigation Improvements; Broward County, Florida

Dear Ms. Jordan-Sellers:

The U.S. Department of the Interior (Department) has reviewed the Draft Environmental Impact Statement (DEIS) for Port Everglades Harbor Navigation Improvements in Broward County, Florida. We have no comments at this time.

If you have questions or need additional information, I can be reached at (404) 331-4524 or via email at joyce_stanley@ios.doi.gov.

Sincerely,

Joyce Stanley, MPA
Regional Environmental Protection Specialist

cc: Jerry Ziewitz – FWS
Gary Lecain - USGS
Anita Barnett – NPS
Chester McGhee – BIA
OEPC – WASH

South
Florida
Regional
Planning
Council

August 13, 2013

Ms. Terri Jordan-Sellers
U.S. Army Corps of Engineers
701 San Marco Blvd.
Jacksonville, FL 32207

RE: SFRPC#13-0602, Army Corps of Engineers FL# 2013-0626-6640C, Feasibility Study and Draft Environmental Impact Statement for navigation improvements to the Port Everglades Harbor in Broward County.

Dear Ms. Jordan-Sellers:

The Port Everglades Harbor Feasibility Study was initiated in 2001 with a primary purpose of investigating improvements to the Federal navigation project at Port Everglades. Proposed improvements focused on ways to 1) decrease costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies through the year 2060; 2) decrease transportation costs through increasing economies of scale for cargo and petroleum vessels through the year 2060; 3) increase channel safety for maneuverability for existing vessels as well as larger next generation vessels requiring more channel depth to operate efficiently; and, 4) comply with USACE environmental operating principles.

We reviewed the above-referenced Feasibility Study and Draft Environmental Impact Statement for the Port Everglades Harbor Channel Expansion Project and have the following comments:

- Port Everglades is a leading container port in Florida, among the most active cargo ports in the United States, and is the main seaport for petroleum products for South Florida. Additionally, the port is one of the three largest cruise ports in Florida; had an economic impact of nearly $26 billion of total business activity in 2012; and, generated $729 million in state and local taxes in 2012.

- The expansion projects at Port Everglades are expected to create 7,000 new jobs in South Florida and support 135,000 new jobs statewide. Today, Port Everglades impacts more than 143,000 Florida jobs, including 10,000 jobs who work directly for companies that offer services to Port Everglades.

- In March 2011, the Broward County Board of County Commissioners unanimously approved the Port Everglades 20-Year Master/Vision Plan that includes market projections and plans for increased berth space to support next generation vessels that require more channel depth to operate efficiently.

- The project should be consistent with the goals and policies of the Florida Department of Environmental Protection's Bureau of Beaches and Coastal Systems, as well as the Broward County's Comprehensive Master Development Plan and its corresponding land development regulations. It is important for the applicant to coordinate permits with all governments of jurisdiction.

3440 Hollywood Boulevard, Suite 140, Hollywood, Florida 33021
Broward (954) 985-4416, State (800) 985-4416
Fax (954) 985-4417, e-mail sfadmin@sfrpc.com, website: www.sfrpc.com

- The project should be closely coordinated with the Broward County's Port Everglades Authority, Broward County Department of Environmental Resource Management, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, and all other applicable agencies of jurisdiction.

- Staff recommends that, if the Project is authorized: 1) impacts to the natural systems be minimized to the greatest extent feasible and 2) the permit grantor determine the extent of sensitive marine life and submerged communities in the vicinity of the project and require protection and/or mitigation of disturbed habitat. This will assist in reducing the cumulative impacts to native plants and animals, wetlands and deep-water habitat and fisheries that the Goals and Policies of the *Strategic Regional Policy Plan for South Florida (SRPP)* seek to protect.

- The Goals and Policies of the *SRPP*, in particular those indicated below, should be observed when making decisions regarding this project:

GOAL 7	**Protect, conserve, and enhance the Region's water resources.**
Policy 7.7	Require all inappropriate inputs into Natural Resources of Regional Significance to be eliminated through such means as redirection of offending outfalls, treatment improvements, or retrofitting options.
GOAL 16	**Enhance and preserve natural system values of South Florida's shorelines, estuaries, benthic communities, fisheries, and associated habitats, including, but not limited to, Florida Bay, Biscayne Bay, tropical hardwood hammocks, and the coral reef tract.**
Policy 16.3	Enhance and preserve coastal, estuarine, and marine resources, including but not limited to, tropical hardwood hammocks, mangroves, seagrass and shellfish beds and coral habitats.
Goal 17	**Maintain a competitive, diversified, and sustainable regional economy.**
Policy 17.4	Continue to seek and take advantage of global opportunities that increase diversification of the Region's economy.
Policy 17.5	Support efforts to solidify the role of international trade in the Region, including South Florida's role in the Free Trade Area of the Americas.

Thank you for the opportunity to comment. If you require further information, please contact me at 954-985-4416.

Sincerely,

Eric Swanson
Regional Planner

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

MARJORY STONEMAN DOUGLAS BUILDING
3900 COMMONWEALTH BOULEVARD
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RICK SCOTT
GOVERNOR

CARLOS LOPEZ-CANTERA
LT. GOVERNOR

HERSCHEL T. VINYARD JR.
SECRETARY

MEMORANDUM

TO: Lauren Milligan, Florida State Clearinghouse Coordinator
Office of Intergovernmental Programs

FROM: Mark Thomasson, P.E., Director, Division of Water Resource Management

Kevin Claridge, Director, Florida Coastal Office

Parks Small, Chief, Bureau of Natural and Cultural Resources
Division of Recreation and Parks

SUBJECT: Department of the Army, Jacksonville District Corps of Engineers
Draft Feasibility Report and Environmental Impact Statement, Navigation Study for Port Everglades Harbor – Fort Lauderdale, Broward County, Florida.
SAI # FL201306266640C

DATE: June 20, 2014

The *updated* Draft Feasibility Report and Draft Environmental Impact Statement (EIS) and the Biological Opinion for the Port Everglades Harbor Navigation Study have been reviewed by the **Division of Water Resource Management** (DWRM). The DWRM staff has been in communication with the U.S. Army Corps of Engineers (USACE) and the Florida Fish and Wildlife Conservation Commission, as well as the Department's Florida Coastal Office and Division of Recreation and Parks, regarding this project for quite a few years, and the Department agreed to become a Cooperating Agency in November of 2007. To date, our efforts to improve the environmental assessment of impacts and to agree on acceptable minimization and mitigation for those impacts have not been entirely successful. We understand the National Marine Fisheries Service (NMFS) has approved a conceptual mitigation plan and has committed to work with this agency to assist in converting their review and scoring to the state required format; however, that has not yet been done. Completion of that effort may satisfy some of the conditions below.

The USACE applied for a major modification to the existing maintenance dredging permit for Port Everglades to include this expansion on July 1, 2013 and subsequently withdrew the application on July 30, 2013. Staff review and comparison of the Draft EIS, permit modification application, and subsequent responses to the draft conditional concurrence determination have raised a number of issues. Previous comments, italicized below, addressed both federal consistency and permitting issues. However, as the modification was withdrawn, the remaining issues are limited to consistency review on the Draft EIS and Feasibility Report.

Since the proposed activities will require state water quality certification in the form of an Environmental Resource Permit and sovereignty submerged lands authorization from the DWRM, as well as the disposition of state-owned lands by the Board of Trustees of the Internal Improvement Trust Fund (Board of Trustees or Governor and Cabinet), the project must meet provisions of Chapters 253, 258, 373 and 403, *Florida Statutes* (F.S.). Should beach placement of sand from the inlet be considered, as proposed in the permit modification application, the provisions of Chapter 161, F.S., shall also apply and a Joint Coastal Permit would be required rather than an Environmental Resource Permit. The DWRM finds the updated Draft EIS and Feasibility Report to be "conditionally consistent" with the Florida Coastal Management Program and makes the following recommendations to provide reasonable assurance that the project will meet state water quality standards, will not be contrary to the public interest, and the use of sovereignty submerged lands and state-owned natural resource lands will meet the requirements for authorization by the Board of Trustees:

1. **Flooding and Flushing Model** – *Deeping the entrance channel, which essentially would increase the cross-sectional flow area, could affect the tidal hydraulics within the confined interior tidal body at a distance from the entrance channel. Should the propagation of the tide through the inlet have the properties of a shallow water wave, the tide range should not be reduced. The celerity of the tide wave would increase where deepened and the timing of the peak current and slack tide would occur earlier away from the entrance channel. Reasonable assurance is required to show that the project will not cause flooding of properties within the confined interior water body. Therefore, provide a flooding model and analysis to evaluate potential inland flooding impacts associated with deepening the channel. On the ebb tide, water is advected seaward through the entrance channel that contains higher concentrations of nutrients and other contaminates compared to levels in the open coast waters. Enlargement of the channel brings the possibility of increasing the flux of these substances out of the inlet and into the coastal waters. Furthermore, the vertical velocity and density structures of tidal flows may be stratified and dependent on the tidal phase. The RMA-2 is a depth averaged model not intended to resolve the vertical features of the channel water column. The field-measurements requested above are necessary to validate the applicability of the RMA-2 model as well as calibrate the model. [§ 373.414(1), F.S.]*

The USACE responded to the Department's request for flood modeling with a statement that modeling is not required because such modeling for port expansions at Jacksonville, Palm Beach and Miami did not appreciably impact storm surge and, therefore, the USACE concluded that flooding due to port expansion at Port Everglades is not expected. The results of a hydrodynamic model that was not calibrated or verified was referenced as additional support for this expectation of no flooding.

The DWRM does not agree that this conclusion can be made from the numerical modeling results at these other port projects because the physical site conditions are not similar. The results of the unverified hydrodynamic model are not adequate as additional support for the USACE conclusion. Similarly, the USACE conclusion regarding the possibility of increasing the flux of nutrients and other contaminants out of the inlet and into the coastal waters is not supported by the hydrodynamic model.

To be consistent, the Department requests hydrodynamic modeling calibrated and verified for Port Everglades that provides adequate engineering data on flooding and flushing. The Department's guidelines for documenting numerical modeling studies can be located on our website, under "Engineering and Reporting Guidelines" at: http://www.dep.state.fl.us/beaches/publications/tech-rpt.htm#Discussion. Data other than numerical models may be considered on a case-by-case basis.

2. **Hardbottom Impacts** – *The Draft EIS does not clearly describe how the hardbottom impact areas were determined. The Draft EIS states that Dial Cordy mapped the area using towed video cameras and benthic assessments; however, no mapping protocols were provided to determine how the mapping was performed. Please provide the estimated acreage of all potential direct and secondary hardbottom impact areas (including the estimated acreage of hardbottom present on the west side slope of the second reef and the east and west side slopes of the third reef) using updated cartographic data (i.e., LADS survey of 2009). Please also provide a formal description of each potential direct and secondary hardbottom impact area with quantitative data on each major functional group (e.g., macroalgae, turf algae, sponges, corals, etc.) and species-indicators (e.g., scleractinian corals, octocorals, etc.), including cover, density, size class distribution, etc., and description of methods used to obtain these data. [§ 373.414(1), F.S.]*

   During permitting, the DWRM will need up-to-date data in sufficient detail for its staff to perform a Uniform Mitigation Assessment Method (UMAM) analysis. The data utilized in the impact assessments, especially in the deeper areas within the channel that were not surveyed (*i.e.*, slopes below -57 ft., and fragments of the third reef within the channel), yet are subject to both direct and indirect impacts, is not sufficient for a UMAM analysis. Although the USACE reports their staff cannot dive in the channel, the state has been to the site and has data showing the high diversity and value of the resources in the channel expansion areas. The impact and mitigation assessment should include these data.

   The applicant will also need to provide a thorough pre-construction survey to accurately classify the habitat and verify the predicted information and potentially adjust mitigation and / or compensatory mitigation allowances.

3. **Mangrove/Seagrass Impacts** – *A map depicting the mangrove and seagrass impact areas was provided in the Draft EIS (Figure 71); however, these areas are difficult to view and evaluate because the scale is small. Please provide a graphic representation of the mangrove and seagrass impact areas with a larger scale. Please show the*

boundaries of the project in relation to the mangrove and seagrass impact areas on the map.

Please provide a detailed description of each mangrove impact area that accurately characterizes the ecological values of the area and functions provided including: types of mangroves, coverage of each type of mangrove, height, general health of the mangroves, coverage and density of nuisance or invasive exotic plant species, wildlife utilization and type of use, and whether any portion of the assessment area has been used as mitigation for a previously-issued permit.

Please provide a detailed description of each seagrass impact area that accurately characterizes the ecological values of the area and functions provided including seagrass species, and the coverage and spatial distribution of each species. Please provide the methodology used to characterize the seagrass areas.

This information was provided in the response, and although the DWRM still has questions and recommendations, these issues could be worked out in the permitting phase.

Secondary Impacts – Identify any secondary impact areas where mangroves and seagrass are in close proximity to the project boundaries. If none are expected, provide an explanation as to how the secondary impacts to these communities will be prevented. [§ 373.414(1), F.S.]

A monitoring plan, designed to measure potential secondary impacts, and an adaptive management plan to cover the associated mitigation, if these impacts should occur, is needed to assure consistency.

4. **Biological Monitoring Plan** – *A detailed Biological Monitoring Plan will need to be provided and, if separate, a Sedimentation and Turbidity Monitoring Plan that measures the biological stress at fixed stations within seagrass and hardbottom resource areas adjacent to the proposed work sites that may experience significant amounts of impact due to turbidity, sedimentation, sloughing or direct physical effects (e.g., anchor or spud placement).*

The provided Miami Harbor monitoring plan is not sufficient to determine potential impacts at Port Everglades. The DWRM worked on and provided a detailed draft of monitoring items needed, including appropriate monitoring locations, appropriate sedimentation monitoring, and appropriate during-construction monitoring to detect potential impacts, including those resulting from excessive turbidity. Our recommendations were not incorporated. A more appropriate monitoring plan which enables accurate detection of project related impacts is required in order to obtain consistency on this matter. The Department suggests referring to the monitoring plan draft mentioned above. [§§ 373.414(1) and 161.041(4), F.S.]

5. **Minimization of Impacts to Hardbottom and Coral Reef** – *DWRM acknowledges that scleractinian corals greater than 10 cm in height or diameter will be transplanted prior to dredging to minimize direct impacts. Corals of a size class 10 cm to 25 cm are the major reproduction pool, as they have achieved a stage of puberty, and they are two orders of magnitude greater in number than corals of class >25 cm, and an order more in diversity (number of species). To minimize the direct impacts to the greatest extent practicable, DWRM staff recommends that, in addition to transplanting all scleractinian corals greater than 10 cm in height or diameter, at least 2,000 octocorals greater than 15 cm in height and at least 300 sponges (Xestospongia muta, Geodia neptuni, Spheciospongia vesparium and Ircinia strobilina), which includes at least 200 sponges greater than 25 cm in diameter and at least 100 sponges greater than 40 cm in diameter, be transplanted as well. [§ 373.414(1), F.S.]*

   The DWRM documentation on species at the site supports inclusion of additional species in the transplantation plan. The USACE response indicates only transplantation of select coral species and did not include octocorals and sponges which, according to our analysis, does not provide adequate minimization measures for the project. The applicant is required to minimize impacts to natural resources, not exclusively corals. In order to obtain consistency with minimization requirements at the state level, the USACE transplantation plan needs to include corals, octocorals, and sponges of specific size / species.

6. **Mitigation** – *The Draft EIS described two potential mitigation options to offset direct impacts to hardbottom. One mitigation option (preferred by the USACE) involves creation of an artificial reef. The other mitigation option (preferred by the National Marine Fisheries Service) involves coral propagation. To mitigate for hardbottom impacts, DWRM staff prefers a combination of both mitigation plans to offset impacts to reef substrate, and creation of onshore and offshore nurseries for corals, octocorals and sponges to enhance the recruitment in natural hardbottom. Please provide a mitigation plan that incorporates both mitigation options. Please include a section for mitigation that is suitable to address impacts due to turbidity and sedimentation.*

   The mitigation plan needs to include functional offsets based on the Uniform Mitigation Assessment Method (UMAM) for both direct AND secondary impacts. Although UMAM will be conducted by the Department, the correct estimates of direct and secondary hardbottom impacts must be provided beforehand.

   In response to concerns about an all boulder mitigation plan being utilized, the USACE proposed a blended mitigation plan. Although the DWRM is in agreement with a blended mitigation plan, and acknowledges that the NMFS has reviewed the plan and scored the plan with their Habitat Equivalency Analysis (HEA), we do not have enough information to show that the plan proposed by the USACE adequately offsets direct and secondary hardbottom impacts. We further understand that NMFS has committed to provide their expertise in assisting the DWRM with converting their HEA scoring analysis to the state required UMAM analysis; however, at this time it has not occurred. To obtain consistency on this matter, the mitigation proposal provided during permitting will have to include sufficient detail and proposed mitigation to adequately offset the project impacts. [§ 373.414(1), F.S.]

Degradation to natural communities adjacent to the project area is likely, due to turbidity and sedimentation. The DWRM recommends that the USACE consider up-front mitigation for degradation of a defined area adjacent to the excavation areas. Such a strategy would avoid any additional mitigation associated with time lag related to the post-construction monitoring period, and possibly avoid the additional costs of remobilization to create additional mitigation in the future.

The USACE addressed mitigation of secondary impacts to 2% of the resources adjacent to the channel and to 10% downslope of the -57 ft. dredge limits. For consistency purposes, an adequate monitoring and adaptive management plan that includes the entire area of secondary impacts will be necessary to assure that the predicted / contingency mitigation is adequate. Without these mitigation issues being fully addressed, the Department is concerned that there is not enough money allocated to mitigation and contingency mitigation to adequately offset the adverse impacts of the project, therefore, the USACE's proposed funding amount for mitigation does not adequately reflect the Department's requirement under Chapter 373, F.S., relating to the public interest.

The Draft EIS states that one mangrove functional unit will be created at West Lake Park to offset 1.16 acres of mangrove impacts, and three seagrass functional units will be created at West Lake Park to offset 4.01 acres of seagrass impacts. Please indicate how the amount of functional units was determined through the UMAM. Also indicate how many acres of mitigation will be provided by one mangrove functional unit and three seagrass functional units. Please provide a letter from either the South Florida Water Management District or Broward County authorizing the proposed mitigation at West Lake Park, and a statement that the proposed mitigation is consistent with the overall mitigation plan for West Lake Park. Please provide a detailed mitigation plan for both mangrove and seagrass impacts including maintenance, monitoring and construction sequence and techniques. Staff requires this information to conduct UMAM for each type of impact. [§ 373.414(1), F.S.]

The USACE has provided further details regarding the mitigation calculations. The DWRM still has questions and concerns on the proposed mitigation at West Lake Park, but can address these issues in the permit phase.

Please be advised that further detailed comments regarding coral and hardbottom impacts, assessment, monitoring and mitigation are provided on Pages 8 through 17 of this memorandum by the Department's Coral Reef Conservation Program.

Thank you for the opportunity to comment. For further information and assistance, please contact Dr. Lainie Edwards, Program Administrator, DWRM, at (850) 245-7617.

The Department's **Division of Recreation and Parks** also appreciates the opportunity to participate in the review of this important project. The following condition (provided by staff of the Bureau of Parks District 5, Office of Park Planning, and Bureau of Natural and Cultural Resources) must also be addressed to ensure compliance with the provisions of Chapters 253 and 258, F.S., regarding impacts to state park lands:

7. **John U. Lloyd Beach State Park Impacts:**

   The preferred alternative indicates that the submerged bulkhead would be installed on the east side of the channel. Based on the maps provided, the bulkhead appears to be recommended in a location that would cut across the park's office/shop area. The proposed location would be quite close to several park staff residences and the ground solar array in that same area. The response provided by the USACE on March 27, 2014, indicates that no further minimization or avoidance of impacts to park lands is possible. However, none of the proposed mitigation would provide on-site improvements to offset the impacts (direct and indirect) to the park. Please contact Division of Recreation and Parks staff to discuss opportunities to mitigate for losses to natural resources, visitor recreation experiences, and potential impacts to park facilities.

   If blasting is required during the dredging process or for the placement of sheet pile bulkhead, impacts to imperiled species, fragile submerged habitats, park resources and facilities, and the park visitor experience could occur. Please provide information on how these impacts will be avoided or minimized. If these impacts cannot be avoided or minimized, please provide information on mitigating the impacts.

   Board of Trustees Authorization – As noted in the Draft EIS, impacts to the state park must meet the Board of Trustees' 1988 POLICY FOR INCOMPATIBLE USE OF NATURAL RESOURCE LANDS. If the parties involved in the proposed disposition of state lands (*i.e.*, Board of Trustees, Division of Recreation and Parks, Broward County, and USACE) agree that Broward County should obtain fee-simple titled ownership of the affected bulkhead area, the County would apply to the Department's Division of State Lands to have the area designated as surplus and sold/deeded to Broward County. If it is determined that the Board of Trustees will retain fee-simple ownership, the County would either: apply for a lease from the Board of Trustees for the bulkhead area, apply for a sublease from the Division of Recreation and Parks, or apply for an easement from the Board of Trustees with the Division of Recreation and Parks' consent.

Any application to use state land which would result in significant adverse impact to state land or associated resources shall not be approved unless the applicant demonstrates there is no other alternative and proposes compensation or mitigation acceptable to the Board of Trustees under § 18-2.018(2)(i), *Florida Administrative Code* (F.A.C.). Any requested use of state land which has been acquired for a specific purpose, such as conservation and recreation lands, shall be consistent with the original specified purpose for acquiring such land in accordance with § 18-2.018(2)(c), F.A.C. Applicants applying for a lease or easement across state land which is managed for the conservation and protection of natural resources shall be required to provide net positive benefit as defined in § 18-2.017(38), F.A.C., if the proposed lease or easement is approved. [§§ 253.03, 253.034 and 253.04, F.S.]

For further information regarding the above condition requirements, please contact Mr. Gregg Walker in the Division of Recreation and Parks at (850) 245-3104.

The Department's **Florida Coastal Office, Coral Reef Conservation Program** (CRCP) staff advises that the provisions of §§ 253.03 and 253.04, F.S., charge the Board of Trustees with the duty to administer and protect sovereignty submerged lands. Chapter 373, F.S., also contains several provisions relating to the public interest in maintaining fishing and recreational values as well as conserving fish and wildlife resources in surface waters and wetlands of the state [§§ 373.414(1)(a)2, 4 and 7, F.S.]. Rule 68B-42.009, F.A.C., explicitly prohibits the take, destruction or sale of marine corals and sea fans. Section 403.93345, F.S., the *Florida Coral Reef Protection Act*, provides for protection of coral reefs and associated reef resources on sovereignty submerged lands off the coasts of Martin, Palm Beach, Broward, Miami-Dade and Monroe Counties. Under this law, the Department is authorized to protect coral reefs through timely and efficient assessment of damages, including civil penalties, resulting from vessel impacts (*e.g.*, anchoring, cable drags, grounding) to coral reefs.

The CRCP finds the Draft EIS and Feasibility Report to be "conditionally consistent" with the Florida Coastal Management Program and makes the following recommendations:

1. **Analysis of Direct and Indirect Impacts.**

   a. **2006 USACE Reef and Hardbottom Survey:** Previously submitted comments regarding the 2006 reef, hardbottom surveys, and channel habitats remain unaddressed. Surveys conducted in the Port Everglades Outer Entrance Channel (OEC) by the Department's DWRM indicate a high species diversity and abundance of scleractinian corals presence in the channel and on the channel walls. Documentation and photos of rich coral community inside the OEC have been provided to the USACE. Without accurate surveys, benthic organism impacts cannot be accurately determined.

The Draft EIS states that, "*Little information has been collected on the biota of the channel and adjacent zones due to the hazard of sampling this area.*" Hazards listed include frequent vessel traffic and substantial currents, both of which could be overcome by a coordinated effort. Communication with the Port, vessel pilots, and U.S. Coast Guard (including topside support from the USCG Auxiliary), could be achieved and would reduce and mitigate vessel traffic issues.

While it is accurate that there are substantial currents in the area, they are frequent and considered to be standard working conditions for the entire region. Additionally, updated *in situ* habitat surveys need to be conducted, including sites that are actually within the Outer Reef direct impact area to accurately quantify the benthic organisms. As this area is not officially in the navigable channel, it is not clear why there are restrictions on USACE contractors being *in situ* to survey this area.

b. **Direct impacts adjacent to and below actual dredging depth:** In June 2008, the USACE informed the NOAA National Marine Fisheries Service (NMFS) that coral reefs located deeper than authorized dredging depth, but still within the proposed expansion to the federal channel would be considered indirect impacts. The Department's CRCP staff respectfully disagree with the USACE conclusion; we believe that coral reefs located within the federal channel that are not dredged but are immediately adjacent to (or below) the dredging depth would be severely and permanently injured through the physical processes of rubble movement and the consistent scouring from vessels transiting the channel. Additionally, these areas will be permanently impacted due to the proposed post-dredging operations and maintenance whereby, "*a drag bar, chain, or other item may be pulled along the channel bottom to smooth down high spots and fill in low spots.*"

These direct impacts are not precisely described in the Draft EIS and should not be included in the discussion of impacts from turbidity and sedimentation, which may be as severe and permanent by occurring through a different mechanism. However, the physical impact to coral reef structure and the biological response to these types of impacts would be different. Each coral reef impact area and type needs to be clearly identified as an impact polygon on a map with a narrative that explains how the impact area was calculated. This detail is needed in the Draft EIS, and similar detail is missing for indirect and direct impacts from anchoring and vessel operations.

The USACE states that the amount of Outer and Middle Reef area to be directly impacted above 57 ft. equates to 15.17 acres. NMFS has determined that impact to the Middle and Outer Reefs, when taking into account the amount of affected reef area below 57 ft., is a total of 21.65 acres – it is requested that this discrepancy in impact acreage be resolved.

c. **Indirect area perimeter and monitoring:** The Draft EIS states that, "*In order to address potential indirect impacts, USACE will monitor a perimeter up to 150 meters away from the dredge footprint (north and south of the channel), and mitigate for apparent effects directly linked to the dredging.*" CRCP staff do not agree that 150 meters surrounding the dredge footprint is sufficient in scope for monitoring (and potentially mitigating for) indirect impacts. The PIANC (2010) report states, "*In some cases, the impact may be confined close to the work area, [while] in others the prevailing currents may transport fine sediments over large distances, with documented cases of impacts occurring > 70 km [approx. 43.5 miles] from the work site.*" Without monitoring a larger area, it may be difficult/limiting to determine if the project has impacted the surrounding reef community and, accordingly, there would be no mitigation requirement for these impacts.

   As a recent example, a 750-meter mixing zone variance was requested for the current Miami Harbor construction. While a mixing zone variance has not yet been requested for this project, CRCP staff suggest that the USACE use a similar mixing zone area to accurately plan monitoring and mitigation for indirect impacts.

   The proposed sampling design does not provide enough detail nor does it provide a power analysis that will allow determination of sample size needed to detect significant differences. Additionally, a new study on the tidal velocity and flow of the water through the Port Everglades Inner Entrance Channel (IEC) has revealed a stratified water column – showing that it is possible for the upper part of the water column to flow in an opposite direction from the lower part of the water column (Stamates *et al.* 2013). This has major implications for turbidity and sedimentation transport, as well as impact monitoring, since previous monitoring protocols were likely not correctly designed to be able to detect changes or impacts. These results will need to be integrated fully into any indirect impact monitoring plans created for this project.

d. **Sub-lethal and lethal impacts:** Although healthy coral reef benthic organisms can often tolerate turbidity and sedimentation from short-term events, the coral reefs in the vicinity of Port Everglades are already under significant stress from other threats (*e.g.*, land based sources of pollution). While we support the USACE's effort to reduce these indirect impacts using Best Management Practices (BMPs) developed by the Southeast Florida Coral Reef Initiative (SEFCRI), CRCP staff are concerned that with such a relatively long-term dredging proposed for this project (estimated from 11 months to 3 years) there may be sub-lethal (*i.e.*, reduced growth rate, bleaching, reduced reproduction) and possibly lethal (mortality, change in species composition) impacts associated (PIANC, 2010). Stress monitoring is still evolving due to the intricacies of understanding individual colony and community stress reactions. As shown in Figure 1, scleractinian corals often have sub-lethal stress effects that can't be easily seen. It is recommended that the benthic monitoring plan take into account these impacts.

Additionally, as recommended by the SEFCRI BMPs document cited in the Draft EIS, dredging should be carefully scheduled to avoid sensitive resource periods such as coral spawning events.

2. Coral translocation/transplantation conditions.

While the Draft EIS states that conditions regarding the transplantation of scleractinian corals will be developed during the pre-construction, engineering and design (PED) phase, it is noted that there are inconsistencies in the sizes of the colonies that will be transplanted. We suggest consideration of the NMFS conditions that require the relocation of: all corals from impact areas listed under the Endangered Species Act, regardless of size; a subset of massive corals and all corals proposed to be listed under the Endangered Species Act that are 5 cm in diameter or larger; and all other corals greater than 10 cm diameter.

Additionally, we suggest consideration for transplanting of the dominant species in these habitats, specifically, octocorals and sponges. They both provide many bioservices including water purification, creating 3-dimensional habitat, and support for a multitude of other important organisms. Extensive dredging projects pose an environmental risk to these communities through increasing turbidity, reducing light, and smothering by sedimentation.

3. Habitat Equivalency Analysis (HEA).

One of the most important variables needed to conduct the HEA is an accurate impact area. As mentioned above, there have not yet been accurate direct and indirect impact areas provided by the USACE; therefore, the HEA presented in this Draft EIS cannot be adequately reviewed at this time. Reaching an agreement on impact assessment is crucial to informing compensatory mitigation. Once impact areas are determined, the HEA must be run again and reviewed by Resource Trustees.

CRCP staff has identified concerns regarding the way the current HEA was conducted, including the following:

a. **Inappropriate use of discount rate:** The USACE's decision to use no (or rather a 0%) discount rate is not an appropriate use of this economic model. Published literature on the HEA, specifically regarding coral impacts, supports the use of a 3% discount rate. As the USACE uses a discount rate of 3.75% in their Draft EIS Economic Analysis, it is unclear why it is being inconsistently applied in the 'Modified HEA.'

b. **Recovery rate:** As stated by the USACE, "*For the purpose of the Port Everglades HEA, the method employed by the Corps uses a Landscape HEA with stony corals as the representative proxy for the entire habitat affected. While stony coral coverage is <1% in the project footprint and vicinity (Gilliam et al. 2004, DC&A 2008), we did not use a proportional analysis to calculate the coral impacts. Instead, the losses are* *calculated as the amount of time it would take for the slowest-growing members of the ecosystem, in this case the stony corals, to recover to baseline, for the entire project footprint."*

CRCP staff support the use of stony corals as the proxy in this model; however, the USACE's proposal to use a 50-year recovery rate for direct impacts and for the compensatory action (boulders) to reach maturity is likely underestimated given the age of the oldest corals in the vicinity is in excess of 100 years.

Dr. Richard Dodge, Dean of the NSU NCRI and HEA expert, conducted an independent technical review of the [US]ACE's HEA values and outputs. Notably, he was unable to replicate the HEA based on the input provided by the USACE. Working with NMFS, he used corrected values (*e.g.*, 3% discount rate, more accurate impact areas, etc.) and created an 'Alternate HEA' requiring an additional 32 acres of mitigation than the USACE's 'Modified HEA.' In addition to the same concerns stated above, his analysis found the following:

- *"The HEA inputs and results in Appendix E2 and not the same as those of the Cost Analysis.*
- *Many of the DEIS HEA input parameters used by the ACE are not supported by the best available science.*
- *The inputs chosen by the ACE for their HEAs underestimate amount of mitigation required.*
- *An Alternate HEA has been developed as part of these comments using: corrected direct impact areas for the Outer and Middle Reefs to include the area below 57'; 3% discount rate; and corrected equivalence that boulders upon maturity reach 50% of services of the natural reef.*
- *The ACE DEIS HEA for Scenario 2 in the DEIS Appendix E Cost Analysis requires 32 acres less mitigation than the more correct Alternate HEA.*
- *Accordingly ACE project mitigation costs are significantly underestimated by using the underestimated mitigation amount.*
- *Table 9 of the Cost estimate there is no justification given for using a much small $ amount for cost per acre of boulders with transplants.*
- *The ACE plan lacks input from the ACE's independent technical review performed by Battelle."*

4. Alternative Mitigation Projects and Cost Estimates (Revised Plan – February 2014).

a. **Repair of grounding sites and subsequent coral installation (transfer from impact sites):** Please revise first sentence as the Southeast Florida Coral Reef Initiative is not related to these grounding sites. The Department's CRCP is the lead resource trustee for un-permitted reef injuries in the southeast Florida region, and is the appropriate entity to cite. Restoration of two of the grounding sites is currently underway. While restoration efforts at the additional sites may be warranted, CRCP staff feel that 10.6 acres is an over estimate of these areas. Coordination with CRCP will be required if this alternative is selected. Additionally, the stated estimates of 30 years until 'substantial functional productivity' is reached after restoration – and 'shortened to 10-20 years if corals are transplanted' are unsupported. Please provide citations or remove.

b. **Artificial reef creation using of [sic] quarried or dredged rock:** Upon maturity, boulders themselves, even with stony coral transplants attached, may provide similar but not 100% full ecological services as those of the natural reef. In Miami-Dade County, a 20-year monitoring program was developed to assess the efficacy of an artificial reef project as mitigation for natural reef impacts through the evaluation of colonization and succession of assemblages on two types of artificial reef materials, as well as comparisons to the adjacent natural reefs (Sathe *et al.* 2011). The Year 12 Monitoring Report states, "*The similarity between [natural and artificial] sites does not appear to be converging over time, rather maintaining distinct separation after twelve years, and possibly showing divergence in similarity.*" A Department CRCP study conducted by Gilliam (2012) concluded the length of time boulder reefs require to mitigate lost reef resources in southeast Florida, assuming a total loss of the impacted community from events such as dredging, exceeds the age of the oldest boulder reef assessed in this study (17 years).

c. **Blending of components from various mitigation alternatives/"Reef Creation with Coral Outplants":** CRCP staff does not support the use of artificial boulder reefs as the only mitigation option; however, we do support their limited use as part of a suite of mitigation projects. We support this option [formerly the Preferred Reef Mitigation Alternative 2 (NMFS-Developed Plan)] as the primary way to mitigate for the lost ecosystem services of the benthic veneer. This, coupled with limited use of boulders to support the propagation nurseries (to mitigate for the volume of Outer Reef that will be permanently lost), is a more appropriate scale and type of mitigation.

   We also support the statement that, "*decisions regarding which species to propagate and outplant (in addition to staghorn coral) and the balance (relative percent-cover, or relative population densities) among all species would be based on findings from the most recent coral restoration studies, historical survey data, and results of ongoing monitoring throughout the project area.*"

5. Construction/Initial Cost per Hardbottom Habitat Functional Unit.

The USACE's proposals underestimate the true cost of replicating the lost habitat which must take into account geological structural loss (*i.e.*, reef framework), biological structural loss (*i.e.*, size and types of benthic organisms), changes in habitat characterization (*e.g.*, depth, light penetration, temperature, etc.), and long-term (20+ years) monitoring to assess success of the project.

In 2014, as part of the Reef Injury Prevention and Response Program, the Department's CRCP awarded a contract for large scale, deep water reef restoration and coral relocation including the actual costs of engineering design, permitting, and construction implementation for primary restoration at two historic Broward County grounding sites – the *Spar Orion* and *Clipper Lasco*. Restoration costs included appropriate biological and habitat characterization surveys, construction of a limestone boulder reef (3 ft. x 3 ft. minimum) including grout, stony coral transplantation (over 5 cm), long-term monitoring, and all associated permitting and reporting requirements. The total costs were $3,254 per square meter ($m^2$) – roughly $12 Million (M) per acre. The value of coral reef resources designated by the Florida Legislature under the 2009 *Florida Coral Reef Protection Act* (§ 403.93345, F.S.) is $1,000 m^2 – approximately $4 M per acre.

The previously reviewed Interim Draft EIS (2012) stated that, "*The total cost of reef/ hardbottom mitigation is projected to be $32.44M.*" This was based on the USACE's 15.32-acre direct impact estimate – equating roughly $2.1 M per acre. However, the current Draft EIS states that the "*total estimated costs for this alternative, which includes the cost of coral translocation, is estimated at $20.13 M.*" Based on the currently proposed 15.17 acres, this effectively reduces the cost per acre to $1.33 M. This is further reduced if the additional 6.48 acres of direct impact below 57 ft. is taken into account.

6. Changes in Hydrology.

Extensive studies on changes to the sediment budget, changes to freshwater and saline water regimes, and hydrographic surveys were completed for the scoping of the feasibility of this project. However, this information was not used to inform the discussions on potential impacts that will occur to larval distribution or sedimentation on reefs and reef resources after project completion. The Draft EIS references how the sediment budget is not likely to have a cumulative adverse effect on the geology or coastal sediment budget/transfer for the area, but does not use this information in discussing the biological components that may potentially be impacted by these permanent changes.

a. **Impacts to nearshore water quality:** The Draft EIS states that, "*Water quality impacts would only be temporary due to construction activities, and the project would not result in any foreseeable future actions that would result in a cumulative effect.*" An independent technical review was conducted by Jack Stamates of NOAA's Atmospheric and Oceanic Meteorological Laboratory and he states the following:

"*On the ebb tide, water is advected seaward through the Port Everglades Inner Entrance Channel (IEC). Several studies have shown that this water contains higher concentrations of nutrients and microbial contaminates compared to levels typically seen in the coastal ocean [Stamates et al. 2013, Fusch et al., 2011]. There is concern that these substances have the potential to degrade the coastal environment.*

Enlargement of the channel brings the possibility of increasing the flux of these substances out of the inlet and into the coastal ocean."

b. **Potential loss of larval transport connectivity:** One such potential change is the transport of larvae. Although larval impacts are discussed within the Blasting impacts section, there doesn't seem to be any review of how the changes in hydrology from this project will impact their distribution and concentration. As the last remaining nearshore mangrove community in Broward County, the West Lake Park Mitigation Area is a nursery for many juvenile species that will eventually inhabit the offshore coral reef community. The seagrass habitats within the Port may act as stepping stones for these juveniles as they make their way offshore. Once the larvae and juveniles make their way into the IEC and OEC, the stratified water column presumably acts as a direct transport to the open reefs. Currently, the lower different layers of the water column are likely dispersed when they reach the Middle and Outer Reefs – allowing the larvae and juveniles to settle the local reef community. However, if wide swaths of Middle and Outer Reef are removed, the hydrology of the OEC will change substantially, and the larvae and juveniles may be washed out to sea.

Please contact Mr. Kevin Claridge, Director of the Florida Coastal Office, at (850) 245-2101 for additional information and assistance.

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	Sedimentation	Turbidity
STRESS		
Photo-physiological stress	• Reduced photosynthetic efficiency of zooxanthellae and autotrophic nutrition to coral	• Reduced photosynthetic efficiency of zooxanthellae and autotrophic nutrition to coral
Changes in polyp activity	• Extrusion of mesenterial filaments following severe stress • Increased ciliary or polyp activity, and tissue expansion in some species to remove sediment	• Extrusion of mesenterial filaments following severe stress • Increased ciliary or polyp activity to feed
Mucus production	• Mucus production or sheeting to remove sediment	• Evidence of mucus production
SEVERE STRESS		
Sediment accumulation	• Accumulation of sediment on tissue of susceptible growth forms due to failure of mechanisms of rejection	
Change in coral colour	• Change in coral colour arising from changes in the density of zooxanthellae and photosynthetic pigments • Paling of coral due to partial bleaching	• Change in coral colour arising from changes in the density of zooxanthellae and photosynthetic pigments • Darkening of coral in response to reduced light due to photoacclimation
Bleaching	• Considerable whitening of corals due to the expulsion of a large proportion of zooxanthellae from the colony	• Considerable whitening of corals due to the expulsion of a large proportion of zooxanthellae from the colony
PARTIAL MORTALITY		
	• Injury to coral tissue, loss of polyps and partial mortality of the colony • Decrease in (live) coral cover	• Injury to coral tissue, loss of polyps and partial mortality of the colony • Decrease in (live) coral cover
MORTALITY		
	• Mortality of small-sized colonies and partial mortality of large corals • Mortality of susceptible species and size classes. • Decreased density, diversity and coral cover • Changes in community structure • Widespread mortality of corals • Major decreases in density, diversity and coral cover • Dramatic changes in community structure, and shifts towards the dominance of non-coral species, such as sponges and algae	• Mortality of susceptible species and size classes. • Decreased density, diversity and coral cover • Changes in community structure • Wide-spread mortality of corals • Major decreases in density, diversity and coral cover • Dramatic changes in community structure, and shifts towards the dominance of non-coral species, such as sponges and algae

Figure 1: Response of corals to increasing levels and durations of sedimentation and turbidity (PIANC 2010).

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
PROGRAM PLANNING AND INTEGRATION
Silver Spring, Maryland 20910

AUG 13 2013

Colonel Alan M. Dodd, Commander
U.S. Army Corps of Engineers, Jacksonville District
PO Box 4970
Jacksonville, Florida 32232

Dear Colonel Dodd:

The National Oceanic and Atmospheric Administration (NOAA) has reviewed the U.S. Army Corps of Engineers (USACE) Draft Environmental Impact Statement (EIS) entitled *Navigation Improvements – Port Everglades Harbor, Broward County, Florida*. Comments are included from the National Marine Fisheries Service (NMFS), representing NOAA as a cooperating agency on the referenced EIS. NMFS was invited to cooperate on the EIS by the USACE in light of NMFS' jurisdiction over, and expertise in, essential fish habitat (as defined by the Magnuson-Stevens Fishery Conservation and Management Act) and threatened and endangered species (as defined by the Endangered Species Act).

In brief, NOAA believes that the referenced Draft EIS significantly understates the project's impacts to seagrass, coral reef, and mangrove habitat. We also believe that the EIS significantly underestimates the level of mitigation required to compensate for the project's effects. The EIS omits significant input that NMFS has provided and does not address questions that NMFS has raised.

Please see the attached NMFS letter for a full description of NOAA's concerns. Please direct any questions you have regarding these comments to Ms. Jocelyn Karazsia or Ms. Kelly Logan. Ms. Karazsia may be reached at:

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West Palm Beach, Florida 33401
561-249-1925
Jocelyn.Karazsia@noaa.gov

Ms. Logan may be reached at:

National Marine Fisheries Service
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
727-460-9258
Kel.Logan@noaa.gov

Sincerely,

Patricia A. Montanio
NOAA NEPA Coordinator

Enclosures

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AUG 12 2013

Colonel Alan Dodd, Commander
U.S. Army Corps of Engineers, Jacksonville District
PO Box 4970
Jacksonville, Florida 32232

Dear Colonel Dodd:

NOAA's National Marine Fisheries Service (NMFS) has reviewed the draft Environmental Impact Statement (EIS) dated June 14, 2013, entitled *Navigation Improvements, Port Everglades Harbor, Broward County, Florida.* The overall purpose of the project is to provide increased navigational safety, efficiency, and improved economic conditions while limiting impacts to the environment to the maximum extent practical. The U.S. Army Corps of Engineers (USACE) is the lead federal agency and Broward County is the non-federal cost sharing partner for the project. The draft EIS describes a tentatively selected plan (TSP) that includes deepening the Outer Entrance Channel (OEC) to -57 feet mean lower low water (MLLW), widening the OEC to 800 feet, and extending the channel seaward 2,200 feet; deepening the main turning basin to -50 feet MLLW and extending the southeastern boundary of the turning basin an additional 300 feet; widening and deepening the south access channel; and deepening the turning notch (following local sponsor dredging of the same area). Blasting may be needed to remove rocky substrate. Dredge disposal would occur at the existing Port Everglades Harbor Ocean Dredged Material Disposal Site (ODMDS). The draft EIS states the TSP would impact 4.01 acres of seagrass, 15.17 acres of coral reef, and 1.16 acres of mangrove habitat. As detailed below, NMFS believes the draft EIS significantly understates these impacts. These comments reflect the responsibilities of the NMFS under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), Fish and Wildlife Coordination Act, and Endangered Species Act (ESA).

Service as a Cooperating Agency in Development of the EIS

By letter dated October 12, 2007, NMFS accepted the invitation from the USACE to participate as a cooperating agency in development of the EIS. In that letter, NMFS stated it would provide technical assistance on how impacts to threatened and endangered species and to essential fish habitat (EFH) would be identified and mitigated. However, NMFS does not have a NOAA federal action that requires us to adopt the EIS for our purposes (such as issuing an MMPA incidental take authorization).

While this is the third version of the EIS NMFS has reviewed, the draft EIS omits significant input NMFS has provided and does not address questions NMFS has raised. Attachment 1 is the detailed review NMFS provided USACE on July 7, 2011. In lieu of repeating the same comments in this letter, NMFS will focus on the major issues that have not been adequately addressed in the draft EIS, including comments on calculation of impacts to coral reefs, characterization of indirect effects to coral reefs, calculation of seagrass impacts, and seagrass mitigation.

As a cooperating agency, NMFS has responded to requests from the USACE for technical assistance during development of the EIS, including preparation of a report, *Characterization of Essential Fish Habitat in the Port Everglades Expansion Area*, which is draft EIS Appendix H and is part of USACE's EFH assessment, and development of a compensatory mitigation plan for coral reefs that is technically sound and appropriately offsets the impacts to coral reef habitats through active propagation and outplanting of corals. USACE included this mitigation option in the draft EIS as Appendix E-4. In this regard, NMFS also prepared sections of the draft EIS and appendices that describe this mitigation alternative. Lastly, due to the USACE's reluctance to calculate coral reef impacts in the manner NMFS recommended in its comments on earlier versions of the draft EIS, NMFS completed a GIS analysis and technical report characterizing and quantifying the coral reef impacts that would result from the project (Attachment 2).

While NMFS remains hopeful an agreement can be reached on those issues affecting NOAA trust resources, if NMFS and USACE cannot agree on a mutually acceptable mitigation plan to be incorporated in the final EIS, NMFS is considering exercising the option under Section 50 CFR 600.920(k) to refer disputes to the Assistant Secretary of the Army. Further, NMFS may also evaluate the option of referring the matter to the President's Council on Environmental Quality pursuant to Part 1504 of regulations for implementation of the National Environmental Policy Act.

Characterization of Coral Reef Impacts

Calculation of Direct Impacts to Coral Reef Habitat

NMFS and Nova Southeastern University completed a GIS analysis and characterized the coral reef impacts that would result from the Port Everglades Expansion Project and concluded 21.66 acres of coral reef located in the federal channel will be severely impacted by the planned expansion (Attachment 2). This estimate of direct impacts is approximately 6.49 acres more than the estimate in the draft EIS. The USACE's estimate of direct impacts to coral reef habitats is based only on removal by the dredge and is estimated to total approximately 15.17 acres. Coral reef communities in the channel would be directly impacted through (1) removal by the dredge; (2) coral fragments and dredged material, including rubble and sediments, moving downslope or down current and shearing coral reef organisms from the substrate; and (3) fractures in hardbottom and lithified coral propagating into the reef framework, thereby destabilizing attachment of coral reef organisms. The latter two impacts create an unstable coral reef environment resulting in lower coral abundance and fewer large coral colonies. The steeply sloped, eastward facing spur-and-groove reef habitats are particularly at risk from the downslope movement of sediment and rubble. Stabilizing the seafloor following the dredging at Port Everglades may be the most significant measure that could minimize post-injury impacts on the surrounding reef communities and newly established reef organisms on uncovered substrate (Dial Cordy and Associates 2006); however, such stabilization is not proposed in the draft EIS.

Calculation of Potential Impact from Anchor Placement Outside the Channel
Depending on the type of dredge selected, anchoring may be required outside the channel in coral reef and hardbottom habitats. The USACE mitigation plan estimates the anchors would result in approximately 17.13 acres of additional impacts to coral reef and hardbottom habitats. NMFS believes this estimate is too low because the draft EIS uses maps created at a coarse regional scale to calculate the impacts. Brian Walker, Ph.D., of Nova Southeastern University, the cartographer of the maps used by the USACE in the draft EIS, provided NMFS updated acreage calculations based on finer scale maps more suitable for impact assessment at Port Everglades (Attachment 3). NMFS concurs with Dr. Walker's assessment that 19.31 acres (i.e., 2.18 acres more than USACE estimates) of coral reef and hardbottom habitats would be impacted by dredge anchors if this construction strategy is used.

Indirect Impacts to Coral Reef Habitat
The draft EIS describes indirect impacts to 130.37 acres of coral and hardbottom habitat within 150 meters of the channel; however, the draft EIS neither describes how this estimate was developed nor the severity of the impacts expected. While NMFS and Dr. Walker estimate 111.87 acres of indirect impacts to coral and hardbottom habitat would result within the 150 meter zone around the channel, NMFS does not agree that sedimentation and turbidity impacts would be limited to this zone. Chronically high levels of sedimentation and turbidity can be as damaging to coral reefs as acute stress (Rogers 1979).

In the July 2011 letter (Attachment 1), NMFS noted that permit SAJ-2003-00203 for the Key West Harbor dredging project included a more stringent turbidity limit (15 Nephelometric Turbidity Units, or NTUs) than what is normally required by the State of Florida. The basis for this requirement was research conducted by Telesnicki and Goldberg (1995) on two Florida coral species (*Dichocoenia stokesii* and *Meandrina meandrites*). The research measured the photosynthetic and respiratory responses of corals subjected in the laboratory to turbidity ranges of 7 to 9, 14 to 16, and 28 to 30 NTU. By day four for *D. stokesii* and day three for *M. meandrites*, corals exposed to 14 to 16 NTU significantly differed from controls. In both cases, this level of turbidity produced a photosynthesis to respiration (P:R) ratio very close to 1.0; the ratio then declined to a ratio of less than 1.0 after six days. The stress from this level of turbidity also induced mucus production. The researchers concluded, "while other species of scleractinians may have different reactions to turbidity, the data suggest that the standard of 29 NTU above background is not conservative and should be reevaluated." These researchers' findings are relevant to the Port Everglades project. Due to the presence of both corals within the project footprint (Dial Cody and Associates 2006), as well as the presence of designated critical habitat for elkhorn and staghorn corals, NMFS continues to recommend a more conservative turbidity standard for the Port Everglades project.

Should blasting be necessary to construct the channel, the draft EIS indicates sedimentation and turbidity monitoring would be done adjacent to the blast sites. NMFS notes conducting monitoring would not avoid or minimize the effects from blasting. The discussion of indirect impacts in the final EIS should provide a more thorough discussion of impacts from blasting that may occur outside the channel, including the size of material produced, amount of material produced, and locations of areas that may require blasting.

Additional Indirect Impacts to Coral Reef Habitat from Poor Water Quality
The vertical velocity and density structures of the Port Everglades inside channel are stratified and vary depending on the tidal phase (Stamates et al. 2013). The results from the Port Everglades Flow study indicate that it is possible for the upper part of the water column inside the inner entrance channel (the part of the water column most likely to contain excess nutrients and microbial contaminates) to flow in an opposite direction from the lower parts of the water column. Specifically, on the flood tide (as defined from tide tables), the lower part of the inner entrance channel may indeed be flooding but the upper part of the inner entrance channel may remain in ebb for a significant fraction of the time ascribed to the "flood tide." As stated in sub-appendix C, RMA-2 is a depth-averaged 2D model and will not resolve the vertical features of the channel water column. These features, however, may be important when considering impacts within the vicinity of the inlet.

Mitigation for Coral Reef Impacts

The draft EIS indicates the amount of coral reef mitigation is important to the USACE in determining what the draft EIS refers to as a "best buy" for mitigation and to develop an overall project construction cost. However, NMFS determines the Habitat Equivalency Analysis (HEA) presented in the draft EIS is flawed due to the input of assumptions that are not supported by the best available science. The amount of coral reef mitigation in the form of boulder piles is significantly underestimated and subsequently the costs for coral reef mitigation are also significantly underestimated. Replicating the approach presented in the draft EIS with more realistic assumptions for the HEA results in a mitigation requirement of an additional 32 acres (approximately 51 acres total) of boulder piles needed to offset impacts to coral reef habitats at an additional cost of $51M above the cost estimate the USACE developed (approximately $71M total).

The four main areas of disagreement with the way the HEA was used to determine the amount of mitigation are (1) amount of coral reef habitat to be impacted (described in the previous section), (2) equivalence of the impact area to the compensatory action, (3) recovery rate of the mitigation action, and (4) discount rate applied. Additionally, NMFS disagrees with the estimated costs for boulder pile construction, which is a major factor in the determination of a mitigation option as a "best buy." Furthermore NMFS believes the creation of boulder piles will not adequately mitigate for lost critical habitat for elkhorn coral and staghorn coral.

NMFS notes the independent technical reviews completed by Battelle Memorial Institute (Battelle 2011) for the USACE conclude that some assumptions made for the HEA are either unsupported or have not been clearly justified. Furthermore, a replication of the HEA and technical review of the USACE "best buy" mitigation plan was completed by an internationally recognized coral reef scientist, Richard E. Dodge, Ph.D, Dean of the Nova Southeastern University Oceanographic Center, and provided to NMFS on July 15, 2013 (Attachment 4). NMFS scientists have reviewed the HEA performed by Dr. Dodge and affirm its accuracy. The analyses of Dr. Dodge, Battelle (2011), and NMFS arrive at nearly identical conclusions regarding the deficiencies in the HEA performed by USACE. Those deficiencies are described below.

Inadequacy of Boulder Piles as Mitigation

The HEA presented in the draft EIS assumes 100 percent equivalency between the coral reefs that would be impacted and the boulder piles created for mitigation. This is not supported by the best available science. For example, Miller et al. (2009) documented an overall lack of similarity between the benthic species at natural and artificial reefs. Gilliam (2012) concluded the length of time boulder reefs require to mitigate lost reef resources in southeast Florida exceeds the age of the oldest boulder reef examined in the study (17 years). Kilfoyle et al. (2013) showed nearshore natural and artificial hardbottom habitats have dissimilar usage by the early life stages of species managed under the fishery management plan for snappers and groupers with significantly higher abundances occurring on natural nearshore hardbottoms compared to artificial habitat. Battelle (2011) arrives at a similar conclusion. In particular, the USACE's independent panel review panel expressed concerned about the efficacy of mitigation boulders. A pile of boulders is not a coral reef and will not become a coral reef over time, and NMFS disagrees with USACE's determination that boulder piles are in-kind mitigation for coral reef habitat.

Ultimately, the boulders would provide a lower degree of ecosystem services compared to those of a natural coral reef. Battelle (2011) also concludes that some of the assumptions made for the HEA, especially regarding recovery service levels, have not been clearly presented or justified. Specifically, this report states that the assumed 100 percent recovery service level could be overly optimistic. The report acknowledges these values are critical to the HEA and significantly affect the outcomes for the required reef mitigation (Battelle 2011). In the separate analysis performed by Dr. Richard E. Dodge (Attachment 4), an alternative approach to determine equivalency of boulder piles and natural coral reefs is identified. This approach describes an assumption that upon maturity boulders would provide a fraction of the services of the natural reefs (services from structure). This approach is described in Attachment 4 and assumes (for purposes of illustration only) that the artificial reef will provide 50 percent of the services of a natural reef. Both Dr. Dodge and NMFS believe that 50 percent is overly optimistic and not based on the best available science. NMFS believes boulder placement should not be credited with any mitigation value beyond those services provided by the structural components of the reef which the boulders would replace.

The USACE's choice of mitigation is boulder placement with coral transplants. These measures will not provide services upon maturity equivalent to those of the natural reef. Information in the draft EIS states that the recovery rate of boulder piles is 50 years, whereas the cost estimate (draft EIS, Appendix E2) assumes 30 years. The USACE subtracted 20 years from the recovery rate as credit for the coral relocation to the boulder reefs. NMFS acknowledges the Port Everglades Reef Group (2004) discussed allowing a 10-year discount for relocated corals; however, this estimate does not reflect the amount of corals to be relocated by the USACE as project minimization, and this discussion occurred prior to the publication of the USACE and U.S. Environmental Protection Agency's (EPA) Mitigation Rule in 2008.

According to the draft EIS Appendix E2, the total number of corals to be dredged is 100,744. The draft EIS cost estimate indicates up to 12,235 corals would be removed. This would represent a 12 percent reduction in impact and therefore it is not appropriate to credit the boulder reef recovery by 20 years. Furthermore, NMFS does not support crediting the recovery of boulder reefs that have coral transplants, because the transplants are a project minimization measure, not a compensatory mitigation measure. The USACE and EPA's Mitigation Rule (2008) and the Clean Water Act 404(b)(1) Guidelines emphasize that mitigation is sequential: first avoid, then minimize, then perform mitigation for unavoidable impacts. The Mitigation Rule specifically states that compensatory mitigation is only for impacts that cannot be avoided or minimized (Federal Register, Volume 73, Number 70, page 19596, April 10, 2008). This impact minimization measure should be reflected in a corresponding reduction in compensatory mitigation requirements. Thus, it would not be appropriate to also give compensatory mitigation credit to the boulder reef recovery areas that will receive these same coral transplants. This amounts to asking for "credit" twice for the same action. NMFS confirmed this is an accurate interpretation of the Mitigation Rule with EPA headquarters staff via email on July 31, 2013.

Additionally NMFS does not support limiting the amount of relocation to 12,235 coral colonies. Rather, NMFS recommended that USACE establish a performance goal for the relocations of 90 percent for the coral species and size classes presented in Table 2 of the "NOAA Mitigation Alternative," which is located in draft EIS Appendix E-4.

Furthermore, NMFS agrees with the findings of Battelle (2011) that the USACE recovery projection is overly optimistic. In particular, Battelle expressed concern about the unsupported assumptions used in the HEA model analysis. Battelle notes the coral growth rate of *Siderastrea radians* does not support the assumption of the 50-year reef recovery projection. With the given 1.5 millimeters per year growth rate, it will take about 167 years, rather than 50 years, for this coral species to reach 25 centimeters (Battelle 2011). Separately, a NMFS analysis using the very high growth rate of 5 millimeters per year for stony corals suggests that numerous coral species would have a recovery period in excess of 50 years, and likely significantly longer considering the widespread coral recruitment failure documented in the Atlantic and Caribbean (Hughes and Tanner 2000; Williams et al. 2008).

HEA/Resource Equivalency Analysis and the Discount Rate

HEA/Resource Equivalency Analysis (REA) is an economic model. While NMFS agrees that HEA and REA are appropriate models to scale the mitigation requirements in some cases, NMFS notes the HEA is applied by the USACE in a manner in which it was never intended for use. Specifically, USACE applies a zero percent discount rate. A zero percent discount rate means the value of environmental services provided today is the same as the value of environmental services provided 1,000 or more years from now. A zero percent discount rate is contrary to the nearly universally accepted theory that there is a time rate of preference for goods of any kind, material or environmental. HEA is an economic model and is not designed to be used with a zero discount rate.

The application of a zero percent discount rate also significantly affects the mitigation requirement when the HEA presented in the draft EIS assumes the impact areas will recover in

50 years. The draft EIS acknowledges some coral reef habitat will only achieve 15 percent of natural reef services but the draft EIS stops the calculation clock at 50 years. If discounting were in place, this would not affect the mitigation requirement much; however, with a zero percent discount rate, continuing these losses beyond 50 years would result in a significant increase in mitigation requirements. While NMFS is aware the draft EIS stops at 50 years because that is the "project life," this is another example of HEA being applied in a manner inconsistent with its designed application.

The draft EIS states that USACE is prohibited from applying a discount rate due to guidance provided in the Office of Management and Budget Circulars A-4 and A-94 (Regulatory Analysis and Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, respectively). NMFS disagrees with the USACE's interpretation of the Circulars. Specifically, Circular A-94 states, "Specifically exempted from the scope of this Circular are decisions concerning water resource projects (guidance for which is the approved Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies)." The Port Everglades Navigation Improvements study and all its components are water resource development projects exempt from Circular A-94. USACE Guidance Documents available for FY12 appear to indicate the USACE should use a discount rate of 4 percent for planning projects[1].

Cost of Boulder Piles

The mitigation plan states the cost per acre ranges from approximately $1M to $1.8M among the four alternatives identified in the plan. However, the draft EIS lists the cost to construct boulder piles in previously permitted artificial reef sites or borrow sites as $588,524 per acre in Table 8 and the cost per acre of boulder piles placed on top of tires as $1,225,000. The draft EIS does not make clear why there is so much variation in costs of different mitigation alternatives describing a similar action. NMFS agrees with Dr. Dodge's assessment (Appendix 4) that the $1.2M estimate per acre is a more appropriate cost. NMFS further notes that the HEA inputs and results in Appendix E2 of the draft EIS are not the same as those of the Cost Analysis.

Boulder Piles and *Acropora* Critical Habitat

NMFS and USACE have held multiple meetings and conference calls regarding the effects to *Acropora* critical habitat from this project. NMFS remains concerned that the USACE has not adequately addressed the direct, indirect, and cumulative effects on critical habitat from this project. Further, the draft EIS does not explain how the boulder reef mitigation plan would compensate for loss of critical habitat. NMFS does not believe that a boulder reef would satisfactorily address the lost functions and values of critical habitat within the project area over the lifetime of the project. Despite numerous discussions with the USACE on this subject, NMFS remains concerned that the project as proposed would not adequately preserve and protect designated critical habitat which is necessary for the conservation of the species.

[1] http://planning.usace.army.mil/toolbox/library/EGMs/EGM1201combined.pdf

NMFS Recommended Mitigation: Coral Nursery with Outplanting
Considering the unprecedented scale in the southeastern U.S. of the planned coral reef impacts, NMFS presented the USACE with a mitigation plan dated June 7, 2013. The plan consists of propagating corals at one land-based nursery and approximately six nursery sites located offshore of Broward County and then transplanting the reared corals to natural reefs to enhance those reefs or to restore degraded sites. NMFS' recommendation is based on careful evaluation of the expected losses of scleractinian coral and octocorals from the expansion of the Port Everglades OEC and the successes of coral propagation and enhancement programs in Atlantic and Caribbean waters. Because boulder reefs would not adequately offset the functions and values of the reef system which will be impacted as part of the Port expansion project, NMFS recommends this alternative approach using propagation. Furthermore, the NMFS recommended mitigation program is more cost efficient than the USACE "best buy" based on the replicated HEA performed by Dr. Dodge and validated by NMFS.

Elkhorn and Staghorn Coral and Their Designated Critical Habitat

NMFS continues to have significant concerns with the project's impacts to resources protected under the ESA. The most significant impacts are to critical habitat for threatened elkhorn coral (*Acropora palmata*) and staghorn coral (*Acropora cervicornis*). In 2008, NMFS designated critical habitat for these species to support a single, key conservation objective of increasing the frequency of successful sexual and asexual reproduction: staghorn and elkhorn coral reproduce sexually via broadcast spawning and asexually via fragmentation. The essential habitat feature to accomplish this objective is substrate of suitable quality and availability to support successful larval settlement, recruitment, and reattachment of fragments. NMFS defined "substrate of suitable quality and availability" as "natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover" (73 FR 72210).[2] The coral reefs offshore Broward County provide suitable substrate for meeting this key conservation objective.

NMFS believes the draft EIS does not adequately assess the project's impacts to *Acropora* critical habitat. The USACE's analysis of impacts needs to focus on the project impacts on the overall ability of the critical habitat to meet the key conservation objective of supporting successful reproduction. NMFS recommends the analysis address three key issues in this assessment:

1) the direct and indirect impacts to coral reef habitat containing the essential feature,
2) hydrographic changes from the project and their effect on coral reproduction, and
3) beneficial impacts, if any, of the selected mitigation plan to the extent the mitigation plan is included in the USACE's proposed action.

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[2] The draft EIS incorrectly characterizes the essential feature of *Acropora* critical habitat and references the status review which is not an appropriate reference for critical habitat. The final EIS should reference the critical habitat rule directly to accurately describe critical habitat.

In addition to the comments above on the project's impacts to reef areas, NMFS recommends the USACE provide a more complete characterization of the reef habitats associated with the project. Certain types of turf algae will still allow for settlement by *Acropora* larvae. Although the draft EIS states that NMFS has failed to provide a standard protocol for assessing critical habitat, assessing the amount of "substrate of suitable quality and availability" is a basic benthic type characterization which NMFS believes does not require any additional protocol. Even though these direct and indirect impacts lend themselves to expression as areas, the assessment of critical habitat impacts should not be limited to simple area comparisons of the percentage of the entire critical habitat unit being impacted. The analysis should be based on the conservation function lost.

The potential for the widening and deepening of the Port Everglades OEC to affect the functioning of critical habitat through physical changes in the bottom and in local currents remains a major concern. In the 2011 letter, NMFS requested the draft EIS evaluate the potential impacts of creating a "sink" or trench where coral fragments and larvae moving northward or southward along the reef line fall into the channel and become no longer viable. This type of impact not only affects the species directly, it also affects the adjacent critical habitat's ability to support the species. NMFS believes the draft EIS does not adequately respond to these concerns. The draft EIS states multiple times that the currents in the Port Everglades location are "highly unpredictable." The draft EIS discusses the natural reef breaks located in areas between Port of Miami and Port Everglades channels and specifically points out the width of these natural breaks, noting that they are much wider than the proposed cut as part of the Port Everglades channel expansion. However, there is no discussion in the DEIS concerning the depth of these natural breaks and the velocity of the currents through them. NMFS believes that a deeper, narrower "break" would produce a higher velocity current perpendicular to the natural south-north transport of larvae -- and possibly fragment -- transport resulting in the larvae/fragments being washed out of the natural transport pathway, preventing them from landing on suitable substrate, thereby reducing the species' reproductive success and the value of the critical habitat. Because of the need to fully understand impacts, the relative comparison to natural reef breaks is not illuminating. NMFS recommends the USACE provide a detailed hydrographic assessment of the predicted current flow changes post-construction.

The effects of the mitigation plan on the value of *Acropora* critical habitat also needs to be fully analyzed and included in the record of decision for the proposed project. As previously stated, NMFS does not believe the boulder reef mitigation alternative would replace the functions and values of critical habitat lost within the project area over the lifetime of the project. The NMFS recommended mitigation of coral nurseries with outplanting, however, could have significant beneficial impacts on the function of critical habitat. With proper design and operation, this mitigation method could create increased incidences of successful fertilization and fragmentation on both sides of the Port Everglades OEC and increase the conservation function of critical habitat in the vicinity of the project. The USACE needs to fully analyze the net impacts of the project, including the selected mitigation plan, on designated critical habitat, not only to do a thorough comparison of alternatives, but also to ensure the project does not destroy or adversely modify critical habitat, as required by the ESA.

Underestimate of Seagrass Impacts

The draft EIS describes how seagrass beds, in particular *Halodule wrightii, Halophila decipiens,* and *Halophila johnsonii,* expand and contract over time. The seagrass survey data from seven seagrass survey events illustrate this point and are described in Appendix H. In particular, the draft EIS points out this expansion and contraction may be a long-term survival strategy of *H. johnsonii* and other seagrass species (Virnstein et al. 2009). For impact assessment purposes, it is important to consider the broader seagrass habitat and not just the currently vegetated portions. However, the draft EIS describes impacts to seagrass based only on the vegetated portions of the beds documented in the 2009 survey. The draft EIS does not describe impacts to areas historically mapped and previously ground-truthed to contain seagrass. These areas represent the available expansion habitat that will no longer be available after the project is constructed. NMFS believes USACE significantly underestimates the amount of seagrass that would be impacted.

A GIS analysis was used to examine the changes in seagrass coverage between 2000 and 2009. NMFS determined that the cumulative seagrass habitat documented in these seven surveys is approximately 19.45 acres (draft EIS Appendix H), and approximately 8.45 acres of seagrass habitat impacts are proposed[3]. This impact estimate is more than double the seagrass impact described in the draft EIS.

Battelle (2011) also recommended USACE complete a bathymetric survey to identify the extent of potentially suitable seagrass habitat (the report used the more general term submerged aquatic vegetation or SAV). The specific water depths recommended were 0.0 feet to -6.0 feet NGVD. This survey would provide a more complete assessment of seagrass habitat versus seagrass acreage that could then be used as a baseline reference for future seagrass mapping and permitting activities since seagrass bed distribution can vary greatly at any point of time. Fully addressing this recommendation would contribute to resolving concerns NMFS has with the underestimate of seagrass impacts. In the review of a preliminary version of the EIS (Attachment 1), NMFS recommended the draft EIS clearly describe where seagrass impacts would occur and the amount of seagrass habitat present in these areas. The draft EIS does not address this comment.

Seagrass Mitigation

West Lake Park Seagrass Mitigation Credits

The restoration planned to be performed by Broward County at West Lake Park is proposed for use as compensatory mitigation for seagrass impacts associated with the port expansion. However, the restoration was not set up as a mitigation bank when NMFS completed its EFH review of the restoration work under SAJ-2002-0072 (IP-LAO). According to the ledger contained in this permit (Attachment 5), there are 2.2 seagrass credits available at West Lake Park. The USACE mitigation plan describes the need to use 2.4 seagrass credits. Using the

[3] NMFS requires the GIS shapefiles for the revised TSP in order to refine this estimate.

impact estimate that includes 8.45 acres of historically mapped and ground-truthed seagrass habitats and the Unified Mitigation Assessment Method (UMAM) scores applied by the USACE (which are in dispute per the section below), over 5 seagrass credits would be needed from West Lake Park. Thus, using either impact assessment, there are not enough seagrass credits available at West Lake Park.

Low Unified Mitigation Assessment Method Scores

Florida's UMAM was the type of functional assessment used to determine the mitigation amount and the USACE acknowledges in their permit that, "USACE UMAM scores on this project were done separately from those submitted by the applicant in conjunction with South Florida Water Management District, future scoring should be done in line with those values which can be found in the file." In July 2011 (Attachment 1), NMFS requested the functional assessments. The draft EIS does not contain the UMAM score sheets for the impacts or the mitigation so NMFS cannot verify the scoring was done in accordance with the permit. A summary table of the UMAM completed for the impacts is provided in the USACE mitigation plan. Notably, 14 out of the 16 seagrass polygons assessed were given a score of 4 or less (out of 10) by the USACE, which corresponds to the habitat providing "minimal level of support to [benthic community] functions" (Form 62-345.900(2), F.A.C.). Five of the 16 seagrass polygons scored 1 or 2 for benthic community. These scores do not reflect NMFS field observations. Additionally, the USACE did not assign higher landscape support functions to seagrass habitats closer to the inlet and clear oceanic waters. The seagrass UMAM scores also do not reflect the best available science or agency input that was obtained from the USACE in 2005 (Attachment 6).

Inadequacy of Seagrass Habitat Mitigation at West Lake Park

Another issue previously raised by NMFS (Attachment 1) relates to the location of the mitigation site with respect to the impacts. While it may be appropriate to mitigate for seagrass impacts along the south access channel in West Lake Park, seagrass habitats located closer to the Port Everglades Inlet provide different functions than seagrass habitats located in more interior areas of the Port. The seagrass habitats at West Lake Park, which is located further away from the inlet and coral reefs, would not provide the same ecological services as the seagrass impacted through the expansion.

The proximity of seagrass to the Port Everglades Inlet increases the value of the seagrass habitats located near the inlet for oceanic and estuarine spawners. Habitat value during growth to maturity for gray snapper (*Lutjanus griseus*) and bluestriped grunt (*Haemulon sciurus*) is a function of distance from an ocean inlet (Faunce and Serafy 2007). For example, the planktonic larvae of gag grouper (*Mycteroperca microlepis*) move into estuaries and settle in the first available habitat, such as polyhaline seagrass beds near inlets (Ross and Moser 1995). Based on work completed in the Indian River Lagoon, Gilmore (1995) determined that seagrass habitats near ocean inlets offer optimum physical conditions with low variation in temperature and salinity and other physical parameters, as well as proximity to ocean spawning sites for reef species. Seagrass habitats near inlets typically provide habitat for more fishery species than seagrass away from inlets. A faunal transition and fish community change takes place within 5 km (3.1 miles) of the ocean inlet to the lagoon as one proceeds away from the inlet (Gilmore 1995). Other studies (e.g., Bushon 2006; Turtora and Schotman 2010) have also linked species distribution and life history stages as a function of proximity to a coastal inlet. The continuity of the seagrass beds between the mitigation site and the inlet is important to fishery species. The proposed port modifications would further isolate seagrass beds at West Lake Park from the inlet, limiting their value in larval migrations and settlement. Accordingly, NMFS believes the UMAM scores for the West Lake Park seagrass should be lower than what the USACE has provided.

Cumulative Impacts

Coral Reefs and Hardbottoms

As described in Attachment 3, the draft EIS minimizes previous losses of hardbottom due to port construction activities by equating the proposed impacted amount to a percent of all the hardbotttom located offshore Broward County. Equating the project impacts to a percent gives the appearance that impacts would be much less. The actual habitat loss is more relevant. Walker et al. (2012) published a peer-reviewed paper on the estimated historical losses of port and shipping activities in southeast Florida. They estimated that Port Everglades has historically dredged 58.5 acres of hardbottom and buried 178 acres of Outer Reef due to improper dumping of spoil material. Using county-wide mean coral density (2.6 per square meter) and percent cover (3.75 percent), Port Everglades development has historically impacted 6,149,000 corals equating to 180 acres of live tissue area. Using these same numbers and the impact scenarios presented in the draft EIS, scenario 1 (includes anchoring impacts outside the federal channel) would impact 380,000 corals with 1.36 acres of live cover, and scenario 2 (dredging coral reefs above -57 feet MLW and no anchoring impacts) would impact 177,000 corals with 0.63 acres of live cover.

The draft EIS does not describe any cumulative impacts for hardbottom. Although the effect of impacting six million corals is difficult to measure, it undoubtedly has some impact on surrounding communities. In addition, the burial of 178 acres of Outer Reef due to improper spoil disposal has a lasting effect on the system. This spoil remains in place today where rocks of all sizes are piled on the reef. These spoils likely shift during storms and continually impact the local community by scouring the substrate as evident in the Dial Cordy and Associates (2009) benthic assessment of previously impacted sites.

Water Quality

NMFS disagrees with the USACE determination that water quality impacts would only be temporary due to construction activities, and the project would not result in any foreseeable future actions that would result in a cumulative effect. On the ebb tide, water is advected seaward through the Port Everglades inner entrance channel. Several studies of this inlet have shown this water contains higher concentrations of nutrients and microbial contaminants compared to levels typically seen in the coastal ocean (Stamates et al. 2013; Futch et al. 2011). These substances have the potential to degrade the coastal environment. Enlargement of the channel brings the possibility of increasing the flux of these substances out of the inlet and into the coastal ocean.

Endangered Species Act Section 7 Consultation

NMFS continues to work with the USACE to obtain all the information necessary to conduct a Section 7 consultation for ESA-listed species and critical habitat under NMFS purview. Two comments on critical habitat are offered at this time. First, the draft EIS concludes that adverse effects to *Acropora cervicornis* and designated critical habitat from increased sedimentation would be insignificant. NMFS agrees that the findings and evidence reported in the paragraphs preceding that statement may support this finding for the species. However, it provides no basis for the determination about sediment effects to critical habitat. To evaluate that effect, the USACE would need to provide documentation regarding the duration of sediment residence (dependent on grain size and physical oceanography of the area) on adjacent hardbottoms (i.e., the essential feature) to be able to say the effect is insignificant for designated critical habitat. Second, NMFS requests clarification of the following point made in the draft EIS, "hardbottom communities exist in a dynamic environment . . . may be periodically covered and uncovered by sands." NMFS requests a reference for this statement and the periodicity that is being referred to.

Essential Fish Habitat Consultation

As a cooperating agency, NMFS prepared *Characterization of Essential Fish Habitat in the Port Everglades Expansion Area*, which is included in the draft EIS Appendix H. This report describes the EFH and fishery resources in the project area and summarizes the biological resource surveys that have been completed. For complete descriptions of EFH in the project area, NMFS refers to this report. The main categories of EFH and HAPC that would be adversely affected by this project include coral, coral reef, and hardbottom; seagrass; mangrove; the coastal inlet; and unvegetated soft bottom habitats.

The report requires the addition of a section characterizing the existing channel bottom due to review of a video from October 18, 2006, that documents corals in the existing channel bottom. Notably, this video confirms the presence of corals that not only are EFH but also proposed to be listed by NMFS under the ESA, including rough cactus coral (*Mycetophyllia ferox*).

Impacts to Essential Fish Habitat

The USACE provided an initial determination that the project may adversely affect EFH and HAPCs. The USACE determined the magnitude of the impacts varies from temporary and insignificant to substantial and permanent. NMFS believes the impacts of the proposed project, along with project components that have been removed from the federal project but are still being pursued by the Port (i.e., dredging 8.4 acres of mangrove to expand a turning notch), result in more adverse impacts to EFH than what are described in the draft EIS, questioning USACE's conclusion that the project's cumulative impacts are negligible.

Essential Fish Habitat Assessment Information Needs

NMFS has considerable disagreement with the USACE on how seagrass and coral reef impacts and mitigation requirements have been determined. NMFS also has significant disagreement with the USACE on how water quality degradation and cumulative impacts are described in the draft EIS. These issues are identified in the preceding and warrant thorough consideration prior to completing the EFH consultation for this project.

EFH Recommendations

NMFS finds the project would adversely impact EFH. Section 305(b)(4)(A) of the Magnuson-Stevens Act requires NMFS to provide EFH conservation recommendations when an activity is expected to adversely impact EFH. Based on this requirement, NMFS provides the following:

EFH Conservation Recommendations

Prior to dredging seagrass or coral reef and hardbottom habitat to expand the Port Everglades Harbor, NMFS recommends the following:

1. The USACE shall provide a mitigation plan that assumes no less than 21.66 acres of direct impacts to coral reef and hardbottom habitats.
2. The USACE shall provide a mitigation plan that assumes no less than 19.31 acres of anchor impacts, in the case that the dredge equipment selected requires anchoring outside the federal channel.
3. The USACE shall provide a monitoring plan to evaluate physical and biological impacts that may occur outside the channel. This plan shall reflect substantial input by NMFS.
4. The USACE shall provide a mitigation plan that reflects no less than 111.87 acres of indirect impacts that would occur in the 150 meter zone surrounding the federal channel. The final EIS should clearly describe how the amounts of indirect impacts to coral reefs are determined.
5. In the case that blasting is required, USACE shall work with NMFS and other resource trustees to develop a monitoring program. Substantial input from NMFS shall be reflected in the final blasting monitoring plan.
6. The USACE shall update the HEA with scientifically defensible inputs on equivalency of natural coral reefs and boulder piles, recovery rates of dredged coral reef habitat, recovery rates of boulder piles, and discount rates. The final HEA shall reflect actual costs of boulder piles with substantial input from NMFS.
7. The USACE shall adopt a compensatory mitigation plan that is the most technically sound approach to offsetting the loss of coral, coral reef, and hardbottom habitat. The final coral reef mitigation plan shall not take credit twice for coral relocation. The final coral reef mitigation plan shall reflect input from NMFS.
8. As a project minimization measure, the USACE shall relocate all corals in accordance to Table 2 in the draft EIS Appendix E-4. Coral relocation shall occur in expansion areas and previously dredged areas. The coral relocation plan should include clearly defined performance standards, monitoring protocols, and schedule.
9. The USACE shall update the EIS to evaluate the potential for the deepening and widening of the OEC to create a "sink" or trench whereby coral fragments and larvae moving northward or southward along the reef line fall into the channel and become no longer viable. This update to the EIS shall reflect significant input from NMFS.
10. The USACE shall update the EIS to describe no less than 8.45 acres of seagrass habitat impacts. The EIS shall be updated to include historically mapped and ground-truthed

seagrass habitat areas that would be eliminated by dredging and no longer available as contraction and expansion habitat.

11. The USACE shall update the EIS to describe indirect impacts to seagrass habitat. This update shall reflect input from NMFS. Specifically, NMFS requests USACE update the EIS to identify each seagrass impact polygon on a map and provide a narrative that explains how the impact area was calculated for each seagrass impact area.
12. The USACE shall develop supplementary compensatory mitigation for seagrass impacts to account for the loss of all seagrass habitat that has been historically mapped and ground-truthed and will become unavailable as habitat after the dredging occurs. The additional mitigation shall appropriately address seagrass impacts that occur closer to or within the inlet. The plan shall address how the site selection for mitigation locations is supported by the best available literature. This plan should include clearly defined performance standards, monitoring protocols, and schedule. The mitigation amounts shall be based on a functional assessment that reflects NMFS and other resource trustee input.
13. The USACE shall update the cumulative impacts section and description of cumulative impacts to coral reefs and water quality. The EIS should be updated to acknowledge the findings of Walker et al. (2012) that Port Everglades has historically dredged 58.5 acres of hardbottom and buried 178 acres of Outer Reef as dredged material disposal, which resulted in the loss of over six million corals and approximately 180 acres of live coral tissue area.
14. The USACE shall require use of best management practices (BMP) to avoid and minimize the degradation of water quality and minimize impacts to hardbottoms and seagrass habitat, including the use of staked turbidity curtains around the work areas, marking of seagrass and hardbottom habitat to facilitate avoidance during construction, and prohibiting staging, anchoring, mooring, and spudding of work barges and other associated vessels over seagrass and hardbottom. These BMPs shall be coordinated with NMFS for approval prior to commencement of any work.

Section 305(b)(4)(B) of the Magnuson-Stevens Act and implementing regulation at 50 CFR Section 600.920(k) requires the USACE to provide a written response to this letter within 30 days of its receipt. If it is not possible to provide a substantive response within 30 days, in accordance with NMFS's "findings" with the USACE Jacksonville District, an interim response should be provided to NMFS. A detailed response must then be provided prior to final approval of the action. The detailed response must include a description of measures proposed by the USACE to avoid, mitigate, or offset the adverse impacts of the activity. If USACE's response is inconsistent with the EFH conservation recommendations, the USACE must provide a substantive discussion justifying the reasons for not following the recommendation.

Thank you for the opportunity to provide comments. Related questions or comments should be directed to the attention of Pace Wilber, Ph.D., or Ms. Cathy Tortorici. Dr. Wilber can be reached at 219 Fort Johnson Road, Charleston, SC, 29412, by telephone at 843-762-8601, or by e-mail at

Pace.Wilber@noaa.gov. Ms. Tortorici can be reached at the letterhead address. Ms. Tortorici may also be reached by telephone at 727-209-5953 or by e-mail at Cathy.Tortorici@noaa.gov.

Sincerely,

Miles M Croom

for Roy E. Crabtree, Ph.D.
Regional Administrator

Enclosures: Attachment 1: NMFS comments, dated July 11, 2011, on interim draft EIS
Attachment 2: Acreage analysis by NMFS
Attachment 3: Acreage analysis by Dr. Brian Walker, July 15, 2013
Attachment 4: HEA review by Dr. Richard Dodge, July 21, 2013
Attachment 5: West Lake Park mitigation credit ledger
Attachment 6: USACE UMAM scores

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Attachments to the NOAA letter are from previous review of draft EIS documents, are included in the administrative record of the project and are available upon request.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
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August 13, 2013

Mr. Eric Summa, Chief
Environmental Branch,
Planning Division,
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

SUBJECT: Port Everglades Harbor Navigation Improvements Draft Environmental Impact Study and Feasibility Study, CEQ No. 20130178, ERP No. COE-E32085-FL

Dear Mr. Summa:

To fulfill EPA's Clean Air Act (CAA) § 309 and National Environmental Policy Act (NEPA) § 102(2)(C) responsibilities, EPA reviewed the above draft SEIS. Under § 309, EPA is directed to review and comment publicly on the environmental impacts of Federal activities.

EPA's primary concerns involve potentially significant impacts to public water supplies, water quality, aquatic ecosystems including corals and hardbottoms, mangrove wetlands, seagrasses, associated mitigation. Our detailed technical comments are enclosed to assist with the preparation of the final SEIS. EPA is willing to work with USACE to address our significant concerns. Based on our review, we have rated this draft EIS as "Environmental Concerns" (EC-2) rating (EPA's rating criteria can be found at (http://www.epa.gov/compliance/nepa/comments/ratings.html)

Thank you for the opportunity to review this draft SEIS. If you wish to discuss this matter further, please contact Beth Walls, 404-562-8309 or walls.beth@epa.gov, of my staff.

Sincerely,

Heinz J. Mueller, Chief
NEPA Program Office
Office of Environmental Accountability

Enclosures: EPA's Technical Comments

EPA Technical Comments on Draft EIS and Feasibility Study for Port Everglades Harbor Navigation Improvements, Broward County, FL, CEQ No. 20130178

Background

Port Everglades Harbor is located within the cities of Hollywood, Dania Beach, and Fort Lauderdale. Its entrance is approximately 27 nautical miles north of Miami Harbor and 301 nautical miles south of Jacksonville Harbor, Florida.[1]

Port Everglades originally started as a petroleum port[2] and is one of three Florida ports receiving petroleum.[3] It is the main entry and delivery center for petroleum, gasoline and jet fuel for 12 South Florida counties. Nearly one-fifth of Florida's energy requirements and one-fifth of Port Everglades' total revenues comes from petroleum and its byproducts stored and distributed through the Port.[4]

Port Everglades is nationally ranked number 35 for tonnage passing through the port. The Port documented 4,079 vessel calls in 2010.[5] Port tenants include more than 30 shipping lines calling on over 150 ports in 70 countries.[6] Additionally, Port Everglades has a growing cruise ship/passenger vessel presence being a major homeport/destination port for major cruise ship lines. It is one of the world's busiest cruise ports in terms of the number of passengers served. Total annual cruise calls are projected to remain around 2,000 annually.[7]

The Port has access to rail, air, and road transport and land available for storage. It is comprised of three main berthing areas: 1) Northport, which services cruise ships, vessels, tankers, barges, and cargo, 2) Midport, which services cruise ships and cargo, and 3) Southport, which services predominantly container ships with the largest area for growth.[8]

To the east of the Port is a barrier island where a U.S. Navy facility, the Nova Southeastern University Oceanographic Center, a U.S. Coast Guard facility, and the John U. Lloyd Beach State Park and its adjacent beaches are located. South of the Dania Cutoff Canal is the West Lake Park area, the proposed mangrove wetland and seagrass mitigation bank. West of the Port is US Highway 1 flanked by the Fort Lauderdale/Hollywood International Airport. North of the Port is a mixture of small craft waterways and commercial and residential development.[9] The federal Intercoastal Water Way transits through the Port in a north – south direction and serves both barges and recreational vessels.[10] On the ocean side of the barrier island is sandy beach and an offshore reef system.[11]

Purpose & Need: The primary objectives are, through the year 2060, to decrease costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies; decrease transportation costs by increasing economies of scale for cargo and petroleum; and increase channel safety and maneuverability for existing and potentially future larger vessels while complying with USACE environmental operating principles.

Alternatives: The proposed action is comprised of the following components: outer and inner entrance channel, three existing turning basins, creating a fourth turning basin, creating a widener, south access channel, and turning notch.[12] USACE looked at a number of depth and widening alternatives for the outer and inner entrance channel, a number of depth alternatives for the remaining features, and some widening options.

The Tentatively Selected Plan requires the removal of approximately 5.47 million yd^3 of dredged material necessitating the expansion of the existing Port Everglades Offshore Dredged Material Disposal Site,[13] which is being addressed in a separate NEPA action pursuant to the Marine Protection, Research and Sanctuaries Act.[14] The Plan will deepen the outer entrance channel from 45 to 57 feet, extend it 2,200 feet into the ocean, and widen it to 800 feet.[15] Both the inner entrance channel and the main turning basin will be deepened from 42 to 50 feet.[16] The widener, an area of shallow water, will be deepened to 50 and widened to 300 feet.[17] Modifications to the south access channel include widening the "knuckle" area by 250 feet causing the relocation of the US Coast Guard facility, shifting the channel 65 feet to the east to effect a transition from the "knuckle" south to the federal channel, deepening from 42 to 50 feet, and widening a 1,845 foot section by 100 feet and widening by130 feet a section north of the turning notch.[18] The turning notch is to be deepened from 42 feet to 50 feet after the federal sponsor has widened the turning notch by removing 8.6 acres of mangrove wetlands and deepened it to 42 feet.

Affected Environment:

The entrance to the harbor is in the vicinity of three reef tracts: inner (located approximately 100 to 2,000 feet from shore and cresting at 26 feet), middle (located approximately 3,000 to 6,000 feet from shore and in 49 feet of water), and outer (located approximately 8,000 feet from shore and cresting at 52 feet) where all the coral and hardbottom and impacts will occur. These are high-latitude reefs, existing near the northern limit of reef growth in the continental United States.[19] While no longer a growing system, the reef complex provides storm protection, hardbottom habitat for invertebrates and fish species, and recreational uses resulting in economic benefits to South Florida.[20]

The harbor is habitat for seagrasses and mangrove wetlands serving as an estuary for a number of animal and fish species including those protected under the Endangered Species Act. The 287-acre John U. Lloyd State Park is located directly across and parallel to the southport access channel.[21] The State Park's harbor portion includes estuarine tidal swamp (mangroves), estuarine and marine unconsolidated substrates, marine consolidated substrates, and a rare, tropical coastal hammock ecosystem (maritime hammock).[22] These maritime hammocks have become increasingly valuable for their ability to act as "refugia" because of South Florida's near total loss of this plant-community type.[23]

The Florida Department of Environmental Protection designated the waters within the Port as Class III, acceptable for recreation, fish, and wildlife and the waters adjacent to State Park, the Atlantic Ocean, as Outstanding Waters of the State.[24]

Environmental Impacts:

Corals/hardbottom: The most significant impact associated with dredging the outer entrance channel is the permanent removal of coral and hardbottom habitat. The draft EIS indicates the permanent removal of approximately 5.58 acres of the middle reef and approximately 11.09 acres of the outer reef to create the entrance channel flare for vessel safety purposes to address variable and unpredictable cross currents resulting from eddies spinning off the Gulf Stream.[25] It also indicates the potential for another 17.13 acres of reef and nearshore hardbottom could be impacted associated anchoring the cutterhead dredge equipment. EPA notes these estimates do not include direct impacts to the remaining coral associated with the actual construction activity, e.g., cutterhead dredge and confined blasting effects. EPA also notes a discrepancy in defined impacts exists between the USACE and the National Marine Fisheries Service.

Seagrasses: The draft EIS indicates dredging will permanently remove up to 3.57 acres of mixed or monoculture Johnson's seagrass where it occurs along the south access channel and widener and impede post-dredging recolonization as the seagrasses require shallow, 13-14 foot habitats.[26] Again, EPA notes a discrepancy in defined impacts exists between the USACE and the National Marine Fisheries Service.

Mangrove wetlands: The draft EIS indicates the proposed action will only impact 1.6 acres of jurisdictional mangrove wetlands located along the east side of the south access channel along J. Lloyd State Park's western shore.[27] EPA finds a greater wetlands impact (8.59 acres) associated with the close linkage between the turning notch component of the proposed action to be done by the USACE and that being done by the sponsor.[28]

EPA's Technical Comments

Aquatic Ecosystems – *Impacts to corals*

- EPA recommends the final EIS address the discrepancy between National Marine Fishery Service and USACE's findings regarding the occurrence of *A. cervicornis* within the study area.[29] According to NMFS, *A. cervicornis* has been documented within 150 meters of the channel whereas the draft states no *A. cervicornis* colonies have been identified within the channel or border area.
- EPA recommends the final EIS address NMFS findings the USACE coral reef impacts estimates are too low, by approximately 8.16 acres. A concern, NMFS raised back in 2011 which has not been addressed in the 2013 draft.
  - EPA recommends the USACE use the appropriate mapping scale to determine impacts associated with the proposed outer entrance channel deepening and widening component. The County appears to have demonstrated the importance of these coral resources by expending the necessary resources to appropriately characterize impacts. The proposed action represents a significant impact to the County/State's coral resources and the UACE may be able to use and build upon the County's improved mapping efforts.
    - In 2008, Broward County resurveyed the areas using updated lidar technology having higher resolution and better processing capabilities[30] to realize enhanced seafloor depictions over the 2001 survey. According to NSU, a visual inspection of these data showed that several apparent hardbottom features were not depicted in the original 2004 NSU maps made from the 2001 lidar survey data.
  - EPA notes in the mid-2000s the Florida Fish and Wildlife Conservation Commission and Nova Southeastern University, both members of the Port Everglades Research Group, recommended the offshore reefs within the proposed action's footprint be mapped at a finer scale. EPA recommends the construction impacts be re-considered consistent with NFMS determinations as supported by the corresponding State agency. EPA recognizes these entities to be the appropriate expertise for determining hardbottom/reef impacts.

- The impacts associated with construction equipment and activities do not appear to have been considered in the direct impact assessment. In addition to permanent removal, dredging is expected to dislodge coral fragments and rubble causing them to slide down the existing steep slopes to impact down slope the spur-and–grove reef habitats lying outside the dredging footprint. Moreover, it is reasonably foreseeable for the confined blasting to fracture the hardbottom, existing corals and their substrate. The ultimate likely result is an unstable reef substrate. Further increasing the difficulties to recover a damaged coral habitat and detrimentally impacting the resilience of the designated critical coral habitat.
- EPA also recommends the final EIS address NMFS concern regarding the draft's underestimation of cutterhead-dredge impacts within the outer entrance channel. NMFS estimates 19.31 acres of potential impacts compared to USACE's 17.31 acres.
- EPA recommends the final EIS provide coral/hardbottom impact information associated with the use of explosives and a mechanical excavator which is lacking in the draft.
- EPA further recommends the final EIS add a column to Table 18[31] to indicate the potential additional impacts associated with dredging/excavation equipment used.
    - For example, the draft indicates 10 additional reef impacts, plus an additional 7.13 acres assuming the worst case scenario,[32] may be associated with the use of a cutterhead dredge.[33]
    - The draft also indicates an option to cutterhead dredge is the mechanical excavator with the use confined underwater blasting with explosives to break the rock to facilitate dredging.[34] No data has been given regarding the impacts associated with a mechanical excavator or confined blasting.
    - The draft also indicates a hopper dredge has the highest likelihood of adverse turbidity and/or sedimentation effect.[35]
- EPA recommends the final EIS discuss the appropriateness of using cutterhead dredge, with its associated anchoring and cable operation in a sensitive coral reef area.
    - EPA notes the USACE indicated it *cannot dictate types of dredging equipment that a contractor may use (per the Competition in Contracting Act), so the potential remains for all of the potential contractors to propose to use a cutterhead dredge with the traditional anchor cable configuration.*[36] USACE states it can only request the selected contractor to implement an anchoring and vessel operation plan to effectively minimize anchor and cable impacts to hardbottom habitat through its Request for Proposal process, which will include incentives to encourage potential contractors to avoid reef impacts.[37]
- EPA recommends the final EIS discuss potential reef impacts associated with dredge equipment when the 5 – 7 year dredging period is interrupted by storms. As the draft noted, Florida's weather is very dynamic ranging from nor'easters associated with arctic fronts and the tropical depressions and hurricanes from the South Atlantic Ocean.[38]

- EPA recommends the final EIS address NMFS concern for the proposed action's potential to create a gap or vacuum of sufficient dimension it prohibits floating coral fragments and larvae's ability to cross and land in suitable habitat to grow and reproduce. Moreover the documented highly unpredictable offshore currents and eddies combined with the proposed deep and narrow channel may sweep larva out into the deeper waters or into the harbor, ultimately reducing the existing designated critical coral habitat's resiliency. Another concern NMFS raised in 2011, which this 2013 draft does not address.

- EPA recommends the final EIS clarify the appropriateness of the draft's characterization of the percent of the designated critical habitat permanently removed by channel extension as an expression of the significance of the proposed action's impacts to coral habitat.
  - o The draft states [g]*iven the percentage of available NMFS-defined colonizable habitat less than 0.006% (0.02 sq km) of the FL DCH unit would be permanently removed by the TSP's construction.*[39]
  - o EPA finds this characterization does not adequately reflect the nature of the complex reef dynamics, these reefs exist near the northern limit of reef growth, nor appropriately characterize their value, both economically and ecologically. Moreover, it is inconsistent with the impact determinations and associated mitigation protocol.
- EPA recommends the final EIS clarify the draft's explanation of the methodology used to calculate impacts for mitigation purposes.
  - o Several different hardbottom/reef impact acreage numbers appear throughout the draft and its appendices. The Executive Summary indicates 15.23 acres.[40] Direct dredging impacts are indicated to total 16.66 acres.[41] Appendix E-2 refers to 16.64 acres.[42] While Appendix E refers to 15.17.[43] It is unclear where these numbers come from. It was stated without any discussion or explanation, the revised lower number of 15.17 resulted from engineering modifications and better mapping.
  - o The discussion of impact scenario 2 is very confusing. The first paragraph indicates no impacts would occur associated with cables and anchors. Then the following paragraph indicates anchor-cable impacts were calculated at 7.40 acres.[44] It is unclear whether anchor and cable impacts will occur under Scenario 2.
  - o The draft mentions USACE's contractor, Dial Cordy and Associates, mapped the area[45] using video cameras[46] and benthic assessments, but no mapping protocols were provided to describe how the mapping was performed.
  - o Figure 59 cites the habitat maps but no discussion was provided to explain how the polygons were drawn, their criteria, or purpose.[47]
  - o Appendix E is unclear whether the calculations were for a 57 or 59 foot depth.[48]
- EPA recommends the final EIS discuss how it derived its *Species specific impact* as depicted in Tables 2-5.[49]
- EPA recommends the final EIS change the word "buffer" to different word because it is being to reference the cutterhead dredge anchor placement: 150 meters from the channel's edge.[50] This identified "buffer" area is the area being directly impacted by the proposed action's potential use of a cutterhead dredge and its associated anchors. Moreover, its use is inconsistent with the draft's proper use of *buffer*, e.g., marine mammal protection zone from confined underwater blasting,[51] a buffer against poor recruitment years,[52] and mangrove buffer in context of sawfish habitat.[53]
- EPA recommends the final EIS clarify the draft's position the USACE revised the reef impact amount based upon refined engineering analysis, higher resolution habitat maps, refined construction timelines to modified the project's duration, and indirect effects associated with vessel movements as a result of the economic analysis. The draft provided no explanation how these factors revised the number of injured areas depicted in Tables 6 – 10.[54]

Aquatic Ecosystems – *Impacts to Seagrasses*

- EPA recommends the final EIS clarify the draft's seagrass impacts identified as 4.01 acres when it is our understanding the cumulative impacts associated with the Tentatively Selected Plan is approximately 9.492 acres.[55]
  - o EPA recommends the final EIS clarify why the draft[56] does not include:
    - The 1.06 acre of seagrass, and corresponding mitigation, National Marine Fisheries Service's identified in the outer entrance channel in its assessment area number 1.[57]
    - The 2.071 acres of seagrass, and corresponding mitigation, NMFS' identified in the harbor in its assessment area number 2.[58]
  - o EPA recommends the final EIS clarify why the draft[59] is inconsistent regarding seagrass acreage impact calculations with NMFS.
    - USACE's 0.08-acre determination for the inner entrance channel is inconsistent with NMFS' 0.698 acre determination in its corresponding assessment area number 3.
    - USACE's 5.01-acre determination for both the widener and south access channel is inconsistent with NMFS' 5.681 acre determination for its corresponding assessment areas number 4 and 5.
    - USACE's 3.26-acre determination for the widener is inconsistent with NMFS' 4.647 acre determination.
  - o EPA further recommends the seagrass impacts be re-considered consistent with NFMS determinations as supported by the corresponding State agency. EPA recognizes these entities to be the appropriate expertise in the science of fisheries and their associated habitats, i.e., seagrasses.
    - EPA recommends the final EIS clarify why the USACE's snapshot approach to assessing seagrass impacts is based upon the best available science and should be used over NMFS' cumulative cover approach, which NMFS' maintains is best supported by the available science.

Aquatic Ecosystems – *Impacts to Mangroves*

- EPA recommends the final Feasibility Study describe which the draft does not, how impact acres to mangrove and reef/hardbottom habitat were determined.[60]
- EPA recommends the final SEIS clarify the draft's statement *the USACE has determined that although no filling of jurisdictional wetlands will occur as a part of the proposed action....*[61] The draft EIS indicates the proposed installation of *environmentally friendly bulkheads* will impact jurisdictional wetlands.[62]

Aquatic Ecosystems - *Impacts*

- EPA recommends the final EIS address its independent technical review panel[63] concerns the draft does not address all the requirements of the Endangered Species Act, National Environmental Policy Act,[64] and Water Resources Development Act.[65]
- EPA recommends the final EIS discuss port and beach renourishment projects located in the two adjoining coastal counties as part of the cumulative impact analysis.
- EPA recommends the final EIS discuss the sponsor's dredging of the turning notch and the Dania Canal Cutoff,[66] which outside sources report started in July of 2013[67] as part of the

cumulative impact analysis, including impacts upon the proposed mitigation bank, West Park Lake.

Aquatic Ecosystems - *Mitigation – corals/hardbottom*

- EPA recommends the USACE further address the National Marine Fisheries Service's mitigation coral nursery proposal to propagate coral and support active coral reef enhancement for the benefit identified in the draft: ... *it is designed to maximize the chances of successful natural coral reproduction; larval transport; settling and colonization into new areas; and genetic mixing required for survival and recovery of the species*[68] combined with the USACE proposal to create boulder reefs, i.e., substrate for NMFS to colonize using nursery stock.
  - o NMFS' proposal when compared to the USACE's passive, boulder reef approach has environmental data to support its potential for success. However, the question remains as to whether the proposed action's impacts to coral reefs will ever be appropriately mitigated. As noted in the draft, these are high-latitude reefs, existing near the northern limit of reef growth,[69] not in optimal growing conditions, and they exist in a higher stress environment making mitigation efforts challenging at best.
  - o The draft presents only a few papers supporting the use of boulders as appropriate mitigation for lost natural reef habitat. However, a number of studies refute the effectiveness of the proposed mitigation and its purported equivalency to natural habitat. There are few long term studies of artificial reefs pertaining directly to the issue of compensation for function and services of a natural reef.
- EPA recommends the final EIS clarify the draft's apparent misstatement of Port Everglades Reef Group's compensatory mitigation recommendations. PERG's recommendation appears to be for a minimum advisable size of 12-15 cm colonies.[70] However the draft indicated states [o]*ne notable recommendation of PERG that will be implemented is the transplantation of corals larger than 25 cm in diameter/height to the mitigation site.*[71]
  - o EPA recommends the transplanting of corals should be consistent with NFMS determinations as supported by the corresponding State agency. EPA recognizes these entities to be the appropriate expertise for addressing coral mitigation.
- EPA recommends the final EIS address both the National Marine Fishery Service's and USACE's independent own independent technical peer review findings[72] regarding the use of boulder piles and its assumption they will reach 100 percent equivalency with natural coral reefs in 30 years. The USACE's use of Habitat Equivalency Analysis to make this 100 percent equivalency finding introduces potentially significant uncertainty regarding the actual achievement of 100 percent.
  - o USACE in its HEA determinations inappropriately used a "0" discount rate and indicated it did so in compliance with OMB Circulars and Corps regulations and guidance. [73]
    - ▪ However, the referenced OMB Circular specifically exempts from its scope water resource projects.[74] It does not prohibit the proposed action from the use of discount rates greater than "0." Nor does the guidance for the exempted water resource projects[75] prohibit the use of discount rates.
    - ▪ EPA recommends some discount rate greater than 0 percent be used in USACE's HEA analysis in order to attempt to provide sufficient mitigation because the value or services provided by the habitat and communities removed and injured by dredging will

be lost for decades[76] by all estimates and may never achieve 100 percent recovery to present value.

- For example, a 3-percent discount rate with the assumption the USACE's proposed boulder mitigation will upon maturity reach 50 percent, not 100, of the natural reef services has been proposed.
- EPA recommends the discount rate should be re-considered consistent with NFMS determinations as supported by the corresponding State agency. EPA recognizes these entities to be the appropriate expertise for calculating the appropriate HEA.

  - Additionally, USACE's underestimation of impact acreage to corals and hardbottom, as discussed in the above comments on impacts, further adds to the significance of the HEA analysis' uncertainty.
  - EPA recommends the final EIS discuss how the HEA input parameters were selected and whether agreed to by all parties. According to the draft, much appears to have been decided at meetings without clear documentation for those not present at these deciding meetings. No justification has been provided in the draft to justify the actual parameters used.

- EPA recommends the final EIS identify appropriate compensatory mitigation for the "best buy" mitigation plan[77] as proposed should the transplant survival rate be lower than the performance criteria value for the transplantation of stony coral colonies to boulder reefs or alternate locations.
- EPA recommends the final EIS clarify and provide a scientific basis for the drafts' statement the transplantation of corals onto mitigation reefs will reduce the time to *substantial functional productivity* by as much as 20 years.[78] Functional productivity requires the octocorals, sponges, reef fishes and other reef biota be present with community structure similar to pre-impact conditions.
- EPA recommends the final EIS clarify the drafts' apparent double counting of mitigation credits for one action. According to the draft EIS,[79] the total number of corals to be dredged is 100,744. Its cost estimate indicates the relocation of up to 12,235 corals outside of the impact area to boulder- reef recovery areas, a 12% reduction in impact. EPA recommends this impact minimization measure be reflected in a corresponding reduction in compensatory mitigation requirements. It would be inappropriate to also grant compensatory mitigation credit to the boulder reef recovery areas receiving the coral transplants.[80] The effect is getting credited twice for the same action.
- EPA recommends the final EIS clarify during the proposed five year monitoring period how it will be determined that 100% equivalency of natural reef habitat has been achieved when it is expected take decades after boulder reef construction to achieve 100 percent, assuming 100 percent can be achieved. EPA believes it is unlikely in five years to achieve *75% of species found in the impact site shall be present in the mitigation site by the time of the completion of the monitoring period; and percent cover by the major groups of organisms in the mitigation site shall be no less that it was in the impact site.*[81]

Aquatic Ecosystems - *Mitigation – mangrove wetlands*

- EPA recommends the final EIS fully account for all aquatic ecosystem impacts and clarify the draft EIS' allegations of avoidance and minimization of mangrove wetlands and seagrasses. The USACE show cases dropping the turning notch and Dania Cutoff Canal projects from the proposed action as example of its mitigation avoidance[82] in response to stakeholder concerns.[83] EPA encourages the USACE to explain how these wetlands and seagrasses impacts will be *avoided* when the sponsor will likely have destroyed them prior to the proposed action's initiation. EPA also encourages USACE to explain how its proposed avoidance effectively addressed the concerns of its stakeholders.

- o The USACE takes credit for avoiding impacts to 8.59 acres of red and black mangrove wetlands[84] by dropping the turning notch widening/deepening component for economic reasons[85] while knowing the federal sponsor will remove these same wetlands[86] to implement the original, federally proposed, turning-notch widening proposal and to deepen up to 42 feet of the original 50 foot design. The draft EIS indicates the sponsor already has initiated permitting discussions and held a pre-application meeting in August, 2012. Moreover after being deepened to 42 feet by the sponsor, USACE intends take action to further deepen the notch to 52 feet.[87]
  - ▪ EPA notes the draft EIS describes these mangroves to be removed as: [t]*his mangrove area is mitigation for previous wetland impacts associated with the Turning Notch Project (DC&A 2001). During the interagency site visit in May 2008, it was noted this area contains a mature mangrove community and the riprap revetment between the mangroves and open water appears to provide sufficient spacing to allow for detrital exchange and fishery resource access.*"[88]
- o The USACE also takes credit for avoiding significant impacts to mature red and black mangrove wetlands,[89] by dropping the Dania Cutoff Canal component for economic reasons.[90] Hence avoiding18.49 acres of mangrove wetlands.[91] The Dania Cutoff Canal component is now considered to be a non-federally sponsored project,[92] for which dredging commenced in July of 2013.[93] The draft EIS did not discuss USACE's approval of the sponsor's permit for this project.[94] EPA notes the dredged material is being disposed of in a landfill instead of being disposed into the Port Everglades offshore dredged material disposal site.
  - ▪ EPA notes the proposed mitigation for removing these 8.6 acres by the sponsor remain undetermined.[95]
- o EPA recommends the final EIS clarify the draft's claim [t]*he tentatively selected plan now proposes to impact only approximately 1.16 acres of mangroves.*[96] The Turning Notch project will impact an additional 8.59 acres. And the Dania Cutoff Canal project impacted an additional 18.49 acres for a total 28.4 acres of mangrove impacts for which mitigation is only being proposed for 1.16 acres.
- o EPA recommends the final EIS clarify whether the proposed action's mangrove impacts will affect habitat created by the Port as mitigation for previous impacts to native areas of mangrove.[97]

Aquatic Ecosystems - *Mitigation – seagrasses*

- EPA recommends the final EIS clarify the proposed action's seagrass impacts and associated mitigation. The draft states mitigation to offset impacts to 4.01 acres of seagrass will occur at West Lake Park.[98] EPA understands seagrass impacts may exceed 9 acres. See Aquatic Ecosystem – impacts comments below.
- EPA recommends the final EIS clarify how West Lake Park creates sufficient seagrass mitigation credit to offset 4.01 to 9.49 acres of seagrass impacts associated with the proposed action.

- o EPA recommends the final EIS clarify how the best available science and scientific literature supports mitigation of seagrasses at the West Lake Park and is consistent with the federal mitigation rule's requirements.[99]
- o EPA recommends the final EIS address the National Marine Fishery Services' concern regarding Port Everglades seagrasses habitat value to two federally managed species: the gray snapper and blustriped grunt, which is a function of distance from the ocean and inlet which West Lake Park cannot adequately compensate.
- o EPA recommends the final EIS identify how many mitigation credits are available at West Park Lake.
  - The draft states [t]*o offset impacts due to implementation of the TSP, 2.4 seagrass functional units* ... will be provided by West Park Lake.[100] This is to mitigate the draft's identified 4.01 seagrass acres impacted.
  - However, USACE permit SAJ-2002-0072 has authorized only 2.22 seagrass credits.
  - Moreover, NMFS has identified 9.492 acres of seagrass impacts requiring 5.25 seagrass credits.
- EPA recommends the FEIS identify and discuss alternative mitigation plans should West Lake Park provide insufficient mitigation to offset proposed action's impacts.
- EPA recommends the FEIS explain how the seagrass UMAM scores were determined.[101]
- EPA recommends the final EIS clarify the draft EIS' claim it avoided 0.66 acres of seagrasses associated with dropping the Dania Canal Cutoff component since the sponsor currently is dredging this canal.[102]

Aquatic Ecosystems - *Mitigation*

- EPA recommends the final EIS clarify the Port Everglades Navigation Project Mitigation Plan[103] will be in compliance with the *Federal Compensatory Mitigation Rule*, dated April 2008.[104]
- EPA recommends the final EIS address its peer review panel concerns, as the draft did not, regarding the adequacy of the draft's discussion on avoidance, minimization, and mitigation measures for unavoidable impacts to identified resources and ESA-listed species such as the federally threatened Johnson's seagrass (*Halophila johnsonii*).[105]
- EPA recommends the final EIS discuss additional avoidance and minimization measures in accordance to the Clean Water Act[106] because the mangroves, sea grass and coral/hardbottom communities in the area are aquatic resources of national importance. EPA agrees with the Corps finding in the draft EIS: [m]*any of the natural resources in the project area are considered significant under the Corps planning guidance.*[107]
- The EPA requests the final EIS clarify the draft's use *adopted primary* mitigation plan as presented in Table 35.[108] This language appears to be a final statement on proposed mitigation for project impacts when significant doubt exists regarding the proposed mitigation's adequacy.

Water Quality – *public water supplies*

- EPA recommends the final EIS discuss the ground-water related studies conducted to determine the potential impacts to potential public groundwater supplies associated with the proposed construction.

- o The draft's conclusion no substantial impacts to water supplies is expected[109] does not appear to have been supported by a ground water study, which has been done for other port deepening projects, e.g., Savannah and Jacksonville Harbors.
  - For example, there is no information on the whether the cone of depression associated with the nearest municipal water-supply well-field will be impacted. For large municipal wells, cones of depression can extend many miles from the pumped well. The four-mile distance of the nearest municipal water supply well field does not preclude impacts associated with the proposed action's construction.[110]
    - Moreover, the fact that the shallow aquifer is not now used for public water supply does not preclude its current use for private water supplies or for future use as public water supply.
  - One concern is the proposed blasting may facilitate increased porosity and transmissivity of seawater into ground-water dependent public water supplies, particularly during storm events and high tides by fracturing associated with the proposed blasting.[111, 112, 113, 114] South Florida's geology is extensive karst limestone which is very hydraulically conductive. The USACE proposes each blasting charge to be placed in a drilled hole 5-10 feet deep **below** the desired depth,[115] e.g., 57 feet. This blasting may facilitate increased porosity and transmissivity of seawater into ground-water dependent public water supplies, particularly during storm events and high tides.
- EPA recommends the final EIS describe the proposed action's construction impacts to the surficial-aquifer system. The draft does not provide information on how the proposed action will cumulatively affect previous harbor dredging impacts to the surficial aquifer. Nor does it provide any rock-removal volume estimates. No discussion has been provided describing rock-removal impact's the aquifer's porosity and ability to transmit sea water associated with public water supply well-draw downs.

Water Quality – *nutrients*

- EPA recommends the final EIS provide environmental information regarding the proposed action's impacts to nutrient concentrations of the coastal waters. As the existing deepest channel in the vicinity, the Port Everglades Inlet represents the largest source of potential pollutant loads from inlets to the coastal ocean in Southeast Florida.[116] Moreover, Figure 62 depicts the inner and outer entrance channel as a point source of fecal coliforms, enterococci, and *Clostridium perfringens*.[117, 118] EPA notes the referenced USGS study only sampled for microbial constituents of human sewage, and did not include sampling for nutrients.
- EPA recommends the final EIS address those studies indicating the water in the inner entrance channel contains higher concentrations of nutrients compared to levels typically seen in the coastal ocean.[119, 120] Enlargement of the channel may potentially increase the flux of these substances out of the inlet and into the coastal ocean. Moreover, the proposed blasting will potentially significantly increase the groundwater –surface water interface potentially increasing the nutrient enriched ground water to discharge into surface water.
  - o The Port Everglades Flow study results indicate the possibility for the upper water column inside the inner entrance channel (the part of the water column most likely to contain excess nutrients and microbial contaminates) to flow in an opposite direction from the lower water column. As stated in sub-appendix C, RMA-2 is a depth-averaged 2D model

and will not resolve the vertical features of the channel water column. These features, however, may be important when considering impacts within the vicinity of the inlet, e.g., nutrient enrichment concerns.

Water-Quality Impacts - *Turbidity*

- EPA recommends the final EIS evaluate the potential turbidity effects to water quality during the estimated five-seven years of dredging and blasting. Without information to support its conclusions, the draft states water quality impacts are expected to be inconsequential,[121] temporary, and no foreseeable future actions resulting in a cumulative effect.[122]
- EPA recommends the final SEIS fully evaluate the long-term turbidity effects associated with larger ships using a deeper navigational channel. Larger ships are expected to create larger wakes, potentially increasing shoreline erosion effects, and potentially disturbing and re-suspending bottom sediments. Additionally the widening effect associated with the proposed deepening may expose more surface area of unconsolidated sediments to erosion.
- EPA recommends the USACE consider avoidance and minimization techniques to reduce these potential environmental consequences and identify appropriate mitigation to address this concern.

Offshore Dredged Material Disposal Site (ODMDS) Impacts

- EPA recommends the final EIS clarify the deepening and expansion material has not been tested or evaluated pursuant to the Marine Protection, Research and Sanctuaries Act. By stating [i]*mpacts associated with disposal activities at the USEPA designated and authorized ODMDS have been reviewed and addressed in USEPA's 2005 EIS for the designation of the Port Everglades ODMDS. The USACE ... hereby incorporates those analyses into this EIS ...* .,[123] the draft implies the dredged material to be disposed offshore is suitable for ocean disposal without further analysis, study, or testing, which is not a factual determination. See ODMDS comments below.
- EPA recommends the final EIS discuss the impacts to the proposed action should a significant volume of dredged material be unable to meet the required ocean dumping criteria, prohibiting the use of the preferred disposal option, ocean disposal off shore.[124] It remains unknown whether any of this material will meet ocean dumping criteria, require special management practices, or a non-ocean disposal site.
- EPA recommends the final EIS clarify the deepening and expansion material has not been tested or evaluated pursuant to the Marine Protection, Research and Sanctuaries Act. The draft EIS states: [s]*ediments sampled within the OEC, IEC, NTB, MTB, and STB have been tested and found suitable for ocean disposal ...* [125] which appears to imply the material associated with the proposed action has been tested and found in compliance with the ocean disposal criteria. The sediments tested in 2004 were the maintenance material dredged and disposed of in 2006, which is no longer in the basin. Additionally, the harbor has been maintenance dredged at least twice since 2004.
- EPA recommends the final EIS clarify the draft's inconsistent statements. It states, [n]*o sources of pollutants or contaminants have been identified within the construction or disposal areas.*[126] However, it also states, [a]*lthough industrial facilities exist in the area that may have a potential for release of toxic materials, the materials most likely to be discharged are petroleum hydrocarbons, small, undocumented chemical spills, and stormwater runoff from large container and freight yards.*[127] EPA agrees the latter describes potential pollution

and contaminant sources within the construction area, which might impact the material to be dredged and its potential compliance with the ocean disposal criteria.

- EPA recommends the final EIS provide the Tier I analysis Appendix J. The draft indicates it has been performed and is in Appendix J,[128] which it is not. Moreover, Appendix J does not address the requirements of the MPRSA or follow any national or regional guidance for performing a Tier I evaluation.
  - EPA requests the USACE provide it an appropriate Tier I analysis for review prior to the final EIS, since EPA was unable to determine from the draft EIS whether it was consistent with national and regional testing guidance.
- EPA recommends the final EIS clarify it is Section 103, not Section 102 of the MPRSA authorizing the USACE to designate a one-time use of a disposal site.[129]
- EPA recommends the final EIS describe the proposed artificial mitigation site to facilitate the appropriate CWA Section 404 compliance determination. It is not described in the draft.[130] At a minimum, the description should include the site's location and the substrate's characteristics. It is impossible to make a factual determination of compliance without an appropriate description of the proposed disposal site.
- EPA recommends the final EIS clarify the decision not to incorporate the site designation into this draft Port Everglades EIS was a joint EPA/USACE, not solely EPA's.[131]
- EPA recommends the final EIS clarify the ocean dumping criteria are based on a suite of tests including chemical and biological tests, not just chemical testing as implied in the draft.[132]
- EPA recommends the final EIS clarify the dredged material disposed at the ODMDS is not regulated under the Clean Water Act and therefore the CWA's Section 404(b)(1) evaluation guidelines are inapplicable to the ODMDS' use.[133]
- EPA recommends the final EIS define what part of the approximately six million cubic yards is expected to be rock removed (i.e., from the surficial aquifer). The draft indicates a significant quantity of rock will require blasting; approximately 40-50% of the material in the main, south, and north turning basins.[134]

Sea Level Rise

- EPA recommends the final SEIS discuss the effects of anticipated sea-level rise over the 50-year project life in context of the need to construct the proposed action to the proposed depth to accommodate the design vessels. Whether sea-level rise may naturally provide some increased water depth to facilitate deep-draft vessel passage without going to the full TSP depth.
- EPA recommends the final SEIS discuss how the proposed action will incorporate any revisions to the USACE's existing guidance,[135] which expires on September 30, 2013, to reflect updated scientific findings over the proposed action's life.

Storm Surge

- The FEIS should discuss how the storm-surge impact analysis was performed, the assumptions made, and confidence in any model derived results. The draft indicates no storm-surge modeling or analysis was performed.
  - EPA recommends this analysis discussion include worst case scenarios, e.g., slow moving, category 5 hurricane occurring at a high tide with the three sea-level rise

scenarios: baseline, intermediate, and high over the 50-year project life consistent with current USACE guidance.[136]

- o EPA recommends this analysis discussion indicate whether the ADCIRC storm surge simulations were used. E.g., the USACE's Sabine Neches study.[137]
- o EPA recommends this analysis discussion indicate where the changes in peak surge occur in the area associated with the proposed action and what is being impacted. Infrastructure? Residential Areas? The Barrier Island?
- o EPA recommends this analysis discussion describe the cumulative effect of storm-surge and sea level impacts based upon the USACE's existing sea level rise guidance: the three sea-level rise scenarios: baseline, intermediate, and high over the 50-year project life.

- EPA recommends the final SEIS discuss the effects of a deepened channel allowing a greater volume of seawater to penetrate the harbor upon the surrounding areas including environmental justice communities, public water supply facilities, wastewater treatment facilities, and other public infrastructure.
  - o Flooding, erosion, and salt-water intrusion through the porous limestone unit of the surficial aquifer are potential concerns associated with storm surges. The proposed action could possibly breach up to ten[138] or more feet of the surficial aquifer creating extensive fractures facilitating new dissolution areas within the existing karst.
  - o A concern exists for impacts associated with large, slow moving storm events upon areas already susceptible to storm-surge flooding. It is unclear whether the proposed action may exacerbate the storm-surge impacts and associated flooding risk of smaller storms than under existing conditions.
  - o EPA recommends the final SEIS discuss storm-surge impact in context of low and high tides, previous histories of major storm-surge impacts, and sea-level rise.
  - o EPA recommends the final SEIS' discuss the effects of a deepened channel allowing a greater volume of seawater to penetrate the harbor upon the J.U. Lloyd Beach State Park, the harbor's mangrove wetlands and seagrasses.
  - o EPA recommends the final SEIS consider appropriate mitigation measures (e.g., informing the local county's public utilities and emergency management program to allow them to update their storm surge maps, evacuation procedures, increasing storm-water retention areas, etc.).

Air Quality –

- EPA recommends the USACE continue to explore with the applicant additional measures to reduce fossil-fuel use during construction. Additionally, the USACE and applicant should consider mitigative measures for port operations, such as additional repower/electrification of container handling equipment, improved logistics related to container movement, port locomotive idle and shut-off policies, use of biodiesel blends, etc.[139]

- EPA recommends the final EIS identify any sensitive receptors within 1,500 feet (approximately 500 meters) from all air-toxics emission sources because the draft EIS did not address air toxics. Sensitive receptors include hospitals, daycares, nursing homes, schools and other at risk populations. EPA recognizes a substantial area around the port is industrialized. Based upon a cursory review of the study area on EPA's NEPAssist program, no schools or hospitals could be identified within 1,500 feet of major port facilities. EPA requests the USACE identify any potential near-facility sensitive receptors and confirm this information in the final EIS.

Environmental Justice & Children's Health

- Environmental Justice
  - EPA recommends the final EIS provide more information on how it meets Executive Order 12898.[140] The draft generally states the project would benefit shipping and general economy including low –income and minority populations, no identified minority or low income populations were identified in the study area or that would be affected by the project, and stakeholder involvement approach provided a variety of opportunities for affected communities to be involved.[141] No supporting information was provided regarding the above conclusions.
  - EPA recommends the final EIS include demographic information and maps to support its statements made regarding the lack of minority and low-income population in the study area and surrounding community. If the demographic analysis identified any minority and low-income populations, efforts made to meaningfully engage these populations in the decision-making process should be identified including a brief summary of any EJ comments or concerns identified along with USACE's response. In addition, any potential environmental and human health impacts should be identified along with any efforts to avoid, minimize or mitigate the effects. Furthermore, if the project benefits are anticipated for communities with EJ concerns, supporting information should be provided.
- Children's Health
  - EPA recommends the final EIS address impacts to children pursuant to Executive Order 13045[142] pertaining to children's health and safety which directs each Federal agency to make it a high priority to identify and assess environmental health and safety risks disproportionately affecting children and to address these risks.
  - EPA recommends the final EIS include an analysis of impacts to children if there is a possibility of disproportionate impacts related to the proposed action. The analysis and disclosure of potential effects under NEPA is important because physiological and behavioral traits of children render them more susceptible and vulnerable to environmental health and safety risks. Children may have higher exposure levels to contaminants because they generally have higher inhalation rates, eat more food, and drink more water, and relative to their body size. In addition, a child's neurological, immunological, digestive, and other bodily systems are also potentially more susceptible to exposure-related health effects. It is well documented that children are more susceptible to many environmental factors that are commonly encountered in NEPA projects, including exposure to mobile source air pollution, diesel emissions, particulate matter and heavy metals. As mentioned in the Air Quality comments above, the final EIS should identify sensitive receptors such as schools, daycares, and hospitals located near the proposed project area and clearly describe the potential direct, indirect, and cumulative environmental and human health impacts to children.

Editorial Comments –

- EPA recommends the final EIS clarify Figure 13, in the draft EIS, it shows a proposed channel depth at 56 feet[143] but the action proposes an effective 57 foot depth.[144]
- EPA recommends the final EIS clarify the draft EIS' inconsistencies in the turning notch depths. The draft SEIS text indicates USACE plans to deepen the turning notch from 42 to 52 feet[145] but Figure 5 indicates the USACE will deepen to 48 feet.[146]
- EPA recommends the final EIS clarify the projected number of vessel calls for the no action and the proposed action and be consistent throughout the text.
  - The draft EIS indicates the 2060 no action projects are for a minimum of 5,193 vessels calling annually, an increase from the pre-2012 baseline of more than 1,163 vessels annually.[147]
  - The draft EIS indicates the No Action analysis estimates 5,163 vessel calls in 2060, an increase in the 2012 level of 1,646 calls.[148]
  - The draft also states *with* project vessel calls in 2060 are estimated to be 8,693, one call less than estimated *without* project.[149]
  - The draft also states *with* project vessel calls in 2060 are estimated to be equal to or less than the without-project vessel calls.[150]
  - The draft also states the 2060 no action projects 8,984 vessel calls; an increase of 3,691 from 2012 baseline, and 1 call less than with the TSP, 8,983 and the proposed action 2060 calls are projected to be 8,983, one less call than the no action.[151]
  - The draft also states the no action, 2060 vessel project is 5163 while the proposed action's 2060 vessel projection is 5,067.[152]
  - The draft also states the estimated vessel calls *without project* – 8,983 in 2060 and *with project* – 8,983 in 2060.[153]
  - The draft also states the no-action alternative would involve a continued increase in ship calls from the 4,000 vessel call 2012 baseline. The future 2060 *without project* estimate is 5,163 vessel calls an increase of 1,646.[154] EPA's calculator finds 4,000 + 1,646 does not equal 5,163.
- EPA recommends the final EIS clarify Figure 62 as the draft EIS references it for two different figures.[155]
- EPA recommends the final EIS improve on the draft EIS' Figure 64 to make it readable.[156]
- EPA recommends the final EIS make Figure 74 readable.[157]
- EPA recommends the final Feasibility Study clarify where the UMAM calculations are provided. They were not provide in Appendix B of the draft EIS as indicated in the draft Feasibility Study.[158]
- EPA recommends the final Feasibility Study clarify where PERG's Draft Compensatory Mitigation Recommendations can be found. They were not provide in Appendix B of the draft EIS as indicated in the draft Feasibility Study.[159]
- EPA recommends the final EIS reflect updated population numbers as the draft EIS states Florida's 2010 population was 1,748,066.[160]
- EPA recommends the final EIS add TSP to the Acronyms/Definitions of terms list.[161] For example, the draft EIS' Table 18 provides information regarding the habitat impacts of the TSP by plan component but TSP is undefined.[162]
- EPA recommends the final EIS reflect the correct spelling of artificial in the Section 7.2.3 header.[163]

- The draft EIS states [m]*angrove mitigation requirements were determined using the State of Florida's Uniform Mitigation Assessment Method (UMAM) assessment.*" It should be Seagrass, not Mangrove.[164]
- EPA recommends the final EIS clarify the draft's statement [u]*navoidable impacts to mangrove wetlands will be mitigated by using credits (functional units) generated by habitat improvements at West Lake Park.*[165] It should be seagrass, not mangrove.

Region 4 EPA Contacts:

Consistent with EPA/USACE discussions, EPA offers its assistance to address our identified concerns with this draft SEIS prior to publication of the final. The following is a list of staff, their contact information, and expertise areas.

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[1] Section 1.2, p. 2.
[2] Section 3.14, p. 167.
[3] Section 3.18, p. 166.
[4] Section 3.14, p. 167.
[5] Section 3.18, p. 166.
[6] Section 3.18, p. 166.
[7] P. Section 3.8, p. 167.
[8] E.S., p.1.
[9] Section 1.2, p. 2.
[10] Section 1.4, p. 9 – FS.
[11] Section 1.4, p. 8 – FS.
[12] Section 2.2.2, pp. 19 – 22.
[13] Section 2.3.2, p. 27.
[14] 16 USC § 1431 et seq. and 33 USC §1401 et seq. (1988).
[15] Section 2.3.2, p. 27.
[16] Section 2.3.2, p. 27.
[17] Section 2.3.2, p. 27.
[18] Section 2.3.2, p. 27.
[19] Section 3.6.2, p. 108.
[20] Section 3.6.2, p. 108.
[21] Section 2.5.5, p.40.
[22] Section 3.17, p. 162.

[23] Section 3.17, p. 162.
[24] Section 3.9.1, p. 147.
[25] Section 4.5.10.2.2, p. 209.
[26] Section 4.4.1.2., p. 176 and Section 4.5.2.2, p. 191.
[27] Section 4.3.2, p. 172.
[28] Section 2.7.1, p. 44.
[29] Section 4.5.10.2.1, p. 208.
[30] Guilford, J.; Robertson, W.; Ramsay, S., 2008. Evolution of the LADS MkII ALB System: A Comparison of the 2001 and 2008 Broward County Lidar Surveys. Available at http://www.thsoa.org/hy09/0512P_04.pdf.
[31] Section 4.3.2, p. 173.
[32] Section 4.5.10.2.2, p. 211.
[33] Section 4.4.2.2, p. 179.
[34] Section 2.9.1, p. 47.
[35] Section 4.5.10.2.3, p. 213.
[36] Appendix E-2, Section 4.51, p. 12.
[37] Section 4.5.10.2.2, p. 211.
[38] Section 3.3, p. 87.
[39] Section 4.5.10.2.4, p. 220.
[40] P. iv.
[41] Section 4.4.2.2, p. 177.
[42] Section 4.5.1 , p.12.
[43] Section 6.1, p. 22, Table 8, p. 33, and Table 11, p. 37.
[44] Appendix E-2, Section 4.51, p. 12.
[45] Appendix E, Section 1.0, p. iv.
[46] Section 3.6.2, p. 111.
[47] Section 3.7.2.13, p. 137 and p. 140.
[48] Appendix E, Section 6.3.5, p. 34, and Table 10, p. 35.
[49] Appendix E-2, Section 4.5.1.1.1, pp. 13-15.
[50] Section 4.5.10.2.2, p. 211.
[51] Section 2.9.3.2.3, p. 72.
[52] Section 3.6.3.3, p. 117.
[53] Section 3.7.2.2, p. 121.
[54] Appendix E-2, Section 4.6, pp. 17 - 21.
[55] Section 4.3.2, Table 18, p 173.
[56] Section 4.3.2, Table 18, p 173.
[57] Section 3.6.1.1, Figure 49, p. 101.
[58] Section 3.6.1.1, Figure 49, p. 101.
[59] Section 4.3.2, Table 18, p 173.
[60] Section 8.11, p. 138 – FS.
[61] Section 4.7.1, p. 221.
[62] Section 2.7.1, p. 44.
[63] Final Independent External Peer Review Report, Science Reports for the Port Everglades Harbor, Florida, Feasibility Study and Environmental Impact Statement (EIS), by Battelle for USACE Ecosystem Restoration Planning Center of Expertise Rock Island Division (August 17, 2011).
[64] NEPA documents shall use data and incorporate findings from analysis required by other environmental laws (e.g., ESA and the Clean Water Act) to assess the project's effects on listed species and wetland resources and to evaluate avoidance or minimization measures.
[65] WRDA 2007 (Section 2036), projects under the USACE Civil Works program need to ensure that *all significant impacts to ecological resources have been avoided and minimized ... and, unavoidable impacts compensated to the extent practicable.*
[66] Section 4.29.2, Table 38, p. 249 does not include the Dania Cutoff Canal project.
[67] Dania Cutoff Canal Deepening Project Kicks Off, July 10, 2012, see: http://www.dredgingtoday.com/2012/07/10/dania-cutoff-canal-deepening-project-kicks-off-usa/
[68] Section 5.2.3, P. 260.

[69] Section 3.6.2, p. 108.
[70] *Recommendations of the Port Everglades Reef Group Regarding Compensatory Mitigation for Navigational Improvements at Port Everglades Harbor* (May 2005) Section 7.6, p. 25.
[71] Appendix E, Section 6.2, p. 23. See also Section 7.2.3, p. 123 – FS.
[72] Final Independent External Peer Review Report, Science Reports for the Port Everglades Harbor, Florida, Feasibility Study and Environmental Impact Statement (EIS), by Battelle for USACE Ecosystem Restoration Planning Center of Expertise Rock Island Division (August 17, 2011).
[73] Appendix E, Section 1.0, p. iv.
[74] OMB Circular A-94.
[75] Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (1983), available at ftp://ftp-fc.sc.egov.usda.gov/Economics/priceindexes/Data/PrinciplesAndGuidelinesLocalSite.pdf
[76] The draft EIS indicates, without supporting data or studies, [t]he interval required to reach substantial functional productivity of this alternative is estimated to be 30-50 years. And also states without supporting data or studies, its proposed mitigation will shorten this interval to 23-30 years. See: Section 5.2.2, p. 259.
[77] Appendix E, Section 6.3.4, p. 34, and draft EIS, Section 5.2.2, p. 258.
[78] Section 5.2.2, p. 259.
[79] Appendix E2.
[80] Compensatory Mitigation for Losses of Aquatic Resources; Final Rule, 40 CFR Part 230 (2008).
[81] Appendix E-5, Monitoring Plan, p. 19.
[82] ES, p. iv.
[83] Section 1.6, p. 16 – FS.
[84] Section 2.7.1, p. 44.
[85] Section 2.5.5, p. 40 and Figure 9, p. 40.
[86] Section 2.2.2, Figure 5, p. 20.
[87] Section 2.5.5, p. 40.
[88] Section 3.5.2, p. 93.
[89] Section 2.5.5, p. 40.
[90] Section 2.5.5, p. 40.
[91] Section 2.7.1, Table 7, p. 45.
[92] Section 1.4.6, p. 10 - FS.
[93] Dania Cutoff Canal Deepening Project Kicks Off, July 10, 2012, see: http://www.dredgingtoday.com/2012/07/10/dania-cutoff-canal-deepening-project-kicks-off-usa/
[94] Section 4.29.2, Table 38, p. 249 does not include the Dania Cutoff Canal project.
[95] Section 4.29.2, Table 38, p. 249.
[96] Section 7.2.1, p. 122 – FS.
[97] Section 3.5.2, p. 95.
[98] Section 5.0, p 260.
[99] Compensatory Mitigation for Losses of Aquatic Resources; Final Rule, 40 CFR Part 230 (2008).
[100] Section 5.3, p. 260.
[101] Appendix E, Table 2, p. 10.
[102] Section 2.7.1, Table 7, p. 25.
[103] Appendix E, Section 3.0, p. 7-8.
[104] Compensatory Mitigation for Losses of Aquatic Resources; Final Rule, 40 CFR Part 230 (2008).
[105] Final Independent External Peer Review Report, Science Reports for the Port Everglades Harbor, Florida, Feasibility Study and Environmental Impact Statement (EIS), by Battelle for USACE Ecosystem Restoration Planning Center of Expertise Rock Island Division (August 17, 2011).
[106] Section 404(b)(1) Guidelines.
[107] Section 2.3, p. 22 – FS.
[108] Section 7.2.3, p. 124 – FS.
[109] Section 4.7.2, p.222.
[110] Section 4.7.2, p.221.
[111] Section 2.9.2, p. 48.
[112] Section 2.9.3.2.1, p. 67.
[113] Section 2.9.3, p. 65.

[114] Section 4.0, p. 235.
[115] Section 2.9.3.2.2, p. 67.
[116] http://newspaper-edit.wunderground.com/data/hurricane/mwrscrape/www.aoml.noaa.gov/themes/CoastalRegional/projects/FACE/PtEverg.htm
[117] Section 3.9.1, p. 147 - 148.
[118] *Clostridium perfringens (C. perfringens)* is one of the most common causes of food poisoning in the United States. http://www.foodsafety.gov/poisoning/causes/bacteriaviruses/cperfringens/
[119] For example, Stamates, S J, J R Bishop, T P Carsey, J F Craynock, M L Jankulak, C A Lauter, and M M Shoemaker. Port Everglades flow measurement system. NOAA Technical Report, OAR-AOML-42, 2013, 22 pp.
[120] Futch, J.C., D.W Griffin, K. Banks, and E.K. Lipp. 2011. Evaluation of sewage source and fate on southeast Florida coral reefs. *Marine Pollution Bulletin.* 62: 2308-2316.
[121] Section 4.4.3.2, p. 184.
[122] Section 4.29.5, p. 252.
[123] Section 4.7.1, p. 221.
[124] Section 2.9.4, p. 80.
[125] Section 3.1.
[126] Appendix B.
[127] Section 3.10, p. 151.
[128] Section 3.1
[129] Appendix B.
[130] Appendix B.
[131] Section 1.8.
[132] Section 2.9.4.
[133] Appendix B.
[134] Section 2.9.3.2, p. 67.
[135] *Sea-Level Change Considerations for Civil Works Programs*, EC 1165-2-212 (1 October 2011).
[136] ER1165-2-212.
[137] *Surge Sensitivity Analysis for Sabine Neches Water Way Navigation Project* by Ty V. Wamsley, Mary A. Cialone, and Tate O. McAlpin, March 2010, available at http://ww3.swg.usace.army.mil/pe-p/SNWW/Doc/2Sabine%20Surge%20Final%20Draft%203-22-10.pdf
[138] Section 2.9.3.2.2, p. 67.
[139] Section 4.9.5, p. 228.
[140] Executive Order 12898 entitled *Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations.*
[141] Section 6.23, p. 265 – 266.
[142] Protection of Children From Environmental Health Risks and Safety Risks.
[143] Section 2.3.5, p. 37.
[144] Table 31, f.n. 1, p. 117.
[145] Section 2.5.5., p. 40.
[146] Section 2.2.2, Figure 5, p. 20.
[147] Section 2.4, p. 28.
[148] Section 4.5.4.1, p. 194.
[149] Section 4.5.6.2, p. 201.
[150] Section 4.5.9.2, p. 207.
[151] Section 4.9.6, p. 229.
[152] Section 4.9.6, Table 36, p. 230.
[153] Section 4.9.10, p. 234.
[154] Section 4.9.11, p. 234.
[155] Section 3.9.1, p. 147 and Section 3.9.2, p. 148.
[156] Figure 64, p. 150.
[157] P. 182.
[158] Section 7.2.1, p. 123.
[159] Section 7.2.1, p. 123.
[160] Section 3.4, p. 46.

[161] I.e., pp. vii and viii.
[162] Section 7.2, p. 121.
[163] Section 7.2.3, p. 123.
[164] Appendix E, Section 4.1, p-8.
[165] Appendix E, Section 4.4, p. 14.

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August 12, 2013

Alan M. Dodd, U.S Army, District Commander
U.S. Army Corps of Engineers
701 San Marco Boulevard
Jacksonville, FL 32207

RE: Navigation Study for Port Everglades Harbor
Draft Feasibility Report and Environmental Impact Statement – June 2013
Broward County Comments

Dear Colonel Dodd:

On behalf of Broward County, I am pleased to forward the attached comments on the draft documents listed above. We appreciate the opportunity to review and provide input on this critically significant project for Broward County, the South Florida Region, the State of Florida, and the Nation.

In reviewing the document it was evident that the U.S. Army Corp of Engineers (ACOE) conducted a thorough analysis through the draft Feasibility Report and Environmental Impact Statement. The comments provided are intended to bring further clarification to certain items within the draft documents, with the goal off adding value to the overall project as these documents are made final.

Broward County looks forward to our continued partnership as this project moves toward completion of the feasibility phase and into planning, engineering and design. Please contact David Anderton, Assistant Director of Port Everglades, at 954-468-0144 if you have any questions or require additional information on the comments.

Sincerely,

Bertha Henry
County Administrator

Attachment

Cc: Steve Cernak, BC Port Everglades Department, Chief Executive/Port Director
Glenn Wiltshire, BC Port Everglades Department, Deputy Director
David Anderton, BC Port Everglades Department, Assistant Director
Cynthia Chambers, BC Environmental Protection and Growth Management Department, Director
David Hobbie, ACOE
Jerry Scarborough, ACOE
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Terry Jordan-Sellers, ACOE

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Navigation Study for Port Everglades Harbor Draft Feasibility Report and Environmental Impact Statement June 2013 Broward County Comments

This document contains comments on behalf of Broward County on the Draft Feasibility Report and EIS. Comments are organized by report section, beginning with the Draft Feasibility Report, then the EIS, and finally the report appendices.

Draft Feasibility Report Comments

Executive Summary, 3rd paragraph, 1st sentence. *"...Port Everglades is one of three ports in Florida receiving petroleum, is ranked 35th nationally in tonnage, and has a growing cruise ship/passenger vessel presence..."*

The italicized sentence, and paragraph, grossly understates the importance of Port Everglades in terms of both cargo and cruise, as well as its economic significance to the regional economy. We believe it is important that the Executive Summary make a reasonably compelling case for Federal investment in the Port Everglades project. More compelling text to demonstrate the importance of Federal investment in improvements at Port Everglades should include the following:

1) As a cargo port, Port Everglades is ranked 31st nationally in total tonnage, is ranked second among Florida port in terms of foreign trade tonnage and domestic trade tonnage, and is the largest Florida Atlantic coast ports in terms of total tonnage (source: Waterborne Commerce Statistics Center, 2011 data).
2) Port Everglades is an internationally important cruise port. It is the 3rd busiest cruise port in the world and U.S., as measured by total annual multi-day passengers;
3) The cruise industry is vitally important to the port. In 2012, Port Everglades had 838 cruise ship calls, including 199 calls by cruise ships longer than 1,000 feet and 344 calls by Post-Panamax size cruise ships. Port Everglades also homeports the largest cruise vessels in the world, RCI's Oasis Class, with lengths of nearly 1,200 feet, passenger capacities of 6,300 and a crew of more than 2,000.
4) Port Everglades is a major regional economic engine, generating (in FY 2012):
    a. 28,100 direct, indirect and induced jobs,
    b. $1.7 billion in personal income,
    c. $2.9 billion in business activity,
    d. $0.59 billion in local purchases, and
    e. $160 million in state and local taxes.
5) In addition, related port users throughout Florida generate substantial economic activity. These include manufacturers and wholesale and retail distribution firms, which use Port Everglades but may also use other ports and therefore are not totally dependent on Port Everglades. These related port users generate:
    a. 173,300 jobs,
    b. $6.1 billion in personal income,
    c. $22.8 billion in business activity, and
    d. $0.57 billion state and local taxes.

Source: The Local and Regional Economic Impacts of Port Everglades – FY 2012 Final Report

Executive Summary, Page iii, last paragraph, "Discussions include assessed impact acreages, functional assessment output, *and potential compensation derived from the proposed mitigation alternatives.*"

The meaning of the italicized clause is not clear.

Executive Summary page iii: Costs and Benefits of the Tentatively Selected Plan

The benefit-cost ratio for the TSP of 1.59 is inconsistent with the 1.57 on page 73 of the Economics Appendix.

Executive Summary page iv: Table A

The B/C ratio of 1.59 and AAEQ Benefits of $24,820,000 are inconsistent with the 1.57 and $24, 480,000 on page 73 of the Economic Appendix.

Executive Summary, Table A: Tentatively Selected Plan Costs and Benefits

There are several aspects of this Table that are confusing / potentially misleading:

1) Not all the line items listed as included in the subtotal GNF are General Navigation Features (e.g., LERRRDs are not GNF)
2) Expansion of the ODMDS is specifically mentioned in the text but cost is shown as $0 in the table. This needs to be further explained.
3) Not sure why utility relocations are listed below the cost sharing subtotal rather than shown earlier in the table where allocation to either Federal or non-Federal costs can be clearly displayed (this is a 100% non-Federal cost).
4) Construction management (S&I) costs of $1.3 million (0.5%) look extremely low relative to the total project first costs ($282 million). Since S&I costs typically range from 5 to 7.5% of project first costs, this bears explaining.

1.3 STUDY PURPOSE AND SCOPE (GOALS AND OBJECTIVES)

This section should mention the impacts of channel width restrictions on large cruise ships.

Page 6, 1.4.2 Adjacent Facilities ...The port has adequate access to the Florida East Coast Railway links, *with future plans for an intermodal container transfer facility and railway lines.*

The italicized statement is out of date. Construction of the ICTF is underway and will be completed in July 2104 prior to implementation of the TSP.

Page 11, Table 6: Port Everglades Federal Navigation Reports

Study Type column contains "PE" entries, while footnote defines as "PA"

Page 11, *1.5.2 Previous Alternative Formulation Briefings*. An Alternative Formulation Briefing (AFB) was conducted in 2001 and 2005 for the Feasibility Study but resulted in a recommendation to conduct further study. *Several factors contributed to the need for re-formulations including changing conditions in the methodology for calculating transportation benefits, which resulted in the need for a new economic analysis.*

Note AFBs should be plural, not singular. More importantly, is the italicized rationale an accurate reason for both the 2001 and 2005 reformulations? Also, should the most recently completed economic reanalysis also be mentioned?

Page 16: 2.1 General, first paragraph

Need to update to FY 2012 economic benefits of Port Everglades of approximately $26.7 billion annually, supporting almost 201,400 jobs.

Page 16, 2.1 GENERAL..."*Port Everglades is the second busiest multi-day cruise port in Florida with approximately 42 different cruise ships visiting in 2012, representing 15 cruise lines.*"

This gives a somewhat misleading impression. Port Everglades is also the 2nd busiest multi-day cruise port in the world, since the top 3 busiest cruise ports in the world are all located in Florida. To give a proper impression of the intensive use of Port Everglades by the cruise industry you may also wish to mention that those 42 different cruise ships had 838 calls in 2012, 344 of which were by Post-Panamax size cruise ships.

Page 19: 2.2.9 Salinity

Update name to Broward County Environmental Protection and Growth Management Department (BCEPGMD).

Page 20: 2.2.10 Littoral Processes

Recommend that the discussion of the Sand Bypass Project be updated to its current status.

Page 20, 2.2.11 *Historic Conditions*

The discussion in this section is disjointed. It starts in 1927, moving through 1940s, then shifting back to the 19th century, then back to the 1920s. It also shifts from Port history to region, then back to Broward County. It also stops in the 1950s. As a result, it does not portray a coherent image of the Port or the region it serves.

Page 21, Federal Navigation Project, "...Maintenance dredging occurred in 2013 and the next *even*..." "*The estimated volume above design depth is approximately 160,000 cy.*"

Italicized word should be "event" not "even".

Add what volume was dredged during the 2013 maintenance dredging. Also, what is meant by the sentence "*The estimated volume above design depth is approximately 160,000 cy.*"? Does this mean that the project is not currently being dredged to its full design depth and width?

Page 25, 2.3.3 *Local Areas of Particular Concern.* "...(mostly owned by the state but *managaed* by the county)"

Correct spelling to "*managed*"

Page 39: Last paragraph

Description of Midport is outdated. Revise to: "Along with berthing, Midport provides: 1 Panamax gantry crane, one mobile harbor crane, a refrigerated warehouse, several acres of open yard area for containers and neobulk storage, and 8 dockside buildings (Terminals 18, 19, 21, 22, 24, 25, 26, and 29) that are used for passenger facilities. The berth areas adjacent to these terminals are used for both cruise and cargo operations."

Page 41, *2.4.2 Cargo Movements and Fleet Composition.* "Total vessel calls during the period of 1993 to 2010 have declined primarily due to a reduction in passenger cruise ship calls."

To put this reduction in perspective, however, it is suggested that you add: "There are a couple of factors related to this. First, is the elimination of daily cruises to nowhere and second is that the total number and proportion of post-Panamax vessel calls has significantly increased over this same period, reflecting a shift over time to fewer but significantly larger vessels within the port complex."

Pages 41-42: 2.4.2 Cargo Movements and Fleet Composition

Update last paragraph to reflect current cruise line use as follows: "Multi-day cruises include Princess Cruises, Holland America Line, Carnival Cruise Line, Cunard Lines, Celebrity Cruises, Royal Caribbean Cruise Line, Cunard, Seabourn, and Silversea Cruises. Daily cruises include the Balearia Caribbean service to Freeport, Bahamas."

Page 42, top paragraph, "... Cruise ship trends at Port Everglades are changing and are trending toward larger capacity vessels on the order of *3,000 passengers*

Reflecting the size of RCI's Oasis Class, change italicized to *"3000 to 6000 passengers"*

Page 42, 2nd paragraph, *"The cruise market has been shifting from day trips to longer voyages and larger vessels. As such, this is not a sign in market decline, but rather a market shift in the type of cruising, and thus a decrease in daily vessel calls."*

Suggest change to:

"The cruise market has been shifting from day trips by smaller cruise ships to longer voyages by larger vessels. As such, this decrease in daily vessel calls is not a sign of market decline, but rather a market shift in the type of cruising to higher value, multi-day cruises on the largest, newest vessels deployed in the cruise industry."

Page 42, last paragraph, "There is a trend for container vessels calling at deeper sailing drafts inbound and outbound. For example, container vessel calls with 35-foot sailing draft or greater increased from 35 inbound in 2004 *to 104 inbound in 2008*. The increase in deeper draft vessels correlates with the increase in number of *larger Panamax container vessels* calling the port."

This paragraph is out of date. Please update to more current 2011 or 2012 vessel calls and include both Panamax and post-Panamax container vessels.

Page 43, first paragraph, The major global services for container vessels calling on Port Everglades are deployments to and from Australia (AUST), the Far East (FE), Europe (EU), the Mediterranean (MED), and South America (SA). Most of the larger container vessels' calls were either associated with services for the Far East or South America. The FE and MED calls *declined in number from 2006 to 2008 due to the global recession*. The AUST calls in the same time period remained the same, and the SA calls increased

This paragraph is also out of date. Please update to more current 2011 or 2012 vessel calls to reflect recovery in vessel calls since the 2006-2008 recession.

Page 43, 2nd paragraph, "Analysis of Port Everglades compound annual growth rates from 1998 to

2012 showed petroleum tonnages peaking in 2005 and then declining after 2005. Cement peaked in 2006 and then declined. *Table 14 provides more details."*

"The growth in cargo tonnage is indicative of south Florida population growth over this temporal period of analysis."

Table 14 does not provide details on historic growth rates – it displays the CAGR projections for future years. A table showing historic growth rates for different commodity types would be useful, however; and should be added to the document.

"tonage" should be "tonnage"

Also, please review data and revisit the last statement. We believe that growth rates for tonnage, esp. containerized tonnage, have significantly exceeded growth rates for south Florida population (rather than being indicative of..). This is significant in projecting future growth rates, esp. in the out years, if population is to be used as a predictive variable.

Page 45, Table 15: Cruise Passangers and Total Tonnage by Type (2012)

"Passangers" should be "Passengers". Also, TEUs or tonnage inbound and outbound should be shown.

2.4.2 Cargo Movements and Fleet Composition

General Comment. Overall, this section is somewhat disjointed. More importantly, it does not give a coherent and comprehensive view of commodity movements at Port Everglades. Critical items not presented include:

- Description of hinterlands for primary commodities, including competitor ports
- Description of primary commodities on each of the major container services (origins and destinations) and historic growth of same
- Description of cargo recovery & growth since end of 2006-2008 recession
- How generic "economies of scale" paragraph applies in particular to Port Everglades
- Interaction between cruise and cargo at Port Everglades (port operations, joint use facilities)
- Key factors affecting future cargo and fleet growth

3.4 ECONOMIC CONDITIONS.

Page 46, 2nd paragraph of Section: *"The population of Florida in 2010 was 1,748,066."*

1,748,066 was the 2010 population of Broward County. The 2010 population of Florida was 18,801,310 (Economics Appendix, Table 7).

"The urbanized counties that make up Port Everglades' south Florida hinterland have projected growth rates that are close to one-half of the rates for the whole state."

Check your math and revisit this statement. According to population projections in Economics Appendix, Table 7, south Florida hinterland projected growth rates appear to be 98-99% of projected state growth rates. If the statement is intended to mean that the anticipated growth in south Florida population represents nearly one half of the total expected state growth, then that figure is closer to one third and the sentence should be rewritten to clarify that meaning.

3rd paragraph of Section: *"Container tonnage continued to grow through 2008, but too has since declined. The container tonnage historical growth rates, further discussed in the Economic Appendix section 2.0, were generally more conservative than other major U.S. container ports such as Savannah Harbor, reflecting that Port Everglades is a regional hinterland largely confined geographically to the southern part of Florida."*

The referenced container tonnage historical growth rates are not presented either in this section or in the referenced section 2 of the Economic Appendix. The conclusion drawn – that Port Everglades is a regional port with a regional hinterland, and therefore likely to experience lower growth - is a critical assertion and should be supported with data and analysis that lends credibility to this conclusion. The historic growth rates should also be presented in order to provide a basis of comparison with the projected future growth rates presented later in the report.

Page 47, 1st paragraph, "*The projected growth rate for containerized cargo is three percent* as outlined in the Port Master Plan (2006). A factor that will affect this rate is the resumption of discontinued container services by Panamax vessels with one service expected to begin in 2010. The Port is projected to attract additional Post-Panamax service in 2016, greatly increasing the volume of containerized cargo.

This paragraph is out of date and appears to be a holdover from a much earlier, pre-2010 version of the draft Feasibility Report. Projected container growth rates presented in the Economic Appendix, Table 23, for 2017 to 2029 range from 3.81% to 4.24%. There are both Panamax and Post-Panamax services currently calling at the Port in 2013. Also note misspelling of "serice" – should be "service".

Page 47, 3.5 WITHOUT PROJECT CONDITIONS. 5th bullet "...as *futher* described

Misspelling. Should be "further"

Also, please update description of the status of the turning notch project.

Page 49, First Paragraph, "Mediterranean Shipping Company's MSC Maeva..."

This paragraph seems to be out of place. It would fit more appropriately within 3.4 Economic Conditions, as an indicator of the size of vessels in the future containership fleet; rather than in Section 3.5 Without Project Conditions, following a discussion of the turning notch project.

Also, it would bear mentioning that this is a 8,100 TEU capacity vessel and that vessels of this class are now calling (rather than is projected to call) on Port Everglades on a regular basis.

Page 51, 4.2 PROBLEMS AND OPPORTUNITIES. Existing problems include:

> **• navigational safety concerns: inadequate width and depth of the channel to accommodate future vessel fleets, leading to potential collisions, *allisions*, and groundings, and"**

Note that there is inadequate depth and width for the existing vessel fleet, not just the future fleet. This leads to operational inefficiencies and increased transportation costs in addition to the other problems listed. Also, most readers will not know what "*allisions*" means. This is not defined until page 57.

Existing problem definitions in this section are somewhat vague and difficult to follow. Suggest you replace these with the problem definitions contained in the Economic Appendix Section 3.4.

Page 58, The primary problems at Port Everglades are related to container ship operations in the Federal navigation channel leading to the Southport container terminal and cruise ship operations in the Federal navigation channel leading to two of the Port's cruise terminals.

Mention should be made of petroleum cargo vessel light loading problems as well, since a significant portion of the benefits to be described later in the report come from petroleum vessels.

Page 59, 2nd paragraph, 2nd sentence: "There are by-passing restrictions on vessels transiting the South Access Channel, which stop all Panamax and Post-Panamax vessel traffic in the South Access Channel, when Panamax vessels are moored alongside.

After "alongside" add "berths 25, 26/27, and 29."

Page 61, Table 17: Study Objectives Objective 1 Decrease costs associated with vessel delays from congestion, channel passing restrictions, and *berth deficiencies* at Port Everglades through the year 2067.

Do not believe "berth deficiencies" belongs in this objective. Any berth deficiencies are being resolved by Port Everglades as part of capital improvements under the without project conditions.

Page 62, 4th paragraph, The unpredictable cross-currents are an existing problem as presented earlier in this section and *is considered a planning constraint*.

Unpredictable cross-currents are a problem that needs to be addressed in the formulation of alternatives, but is not a constraint that limits formulation.

Page 65, 4. Trucking. Vessels that cannot be accommodated at the port would be redirected to other ports. The commodities would then be trucked to Port Everglades as needed or other locations as needed. This measure could reduce port congestion so it met objective 1.

Trucking is really a misnomer for this non-structural alternative. It is really vessels bypassing Port Everglades to load/offload at another, less cost effective, port. Commodities are then transported to their ultimate hinterland origin/destination by whatever land-based transportation method is appropriate from the alternative port. You can note that this alternative is currently being implemented on container services that have recently left Port Everglades due to channel depth restrictions.

Page 65, 5. Off-Loading Cargo. It would increase port congestion *because at least two vessels would be entering rather than the original, larger vessel*...It is not likely to decrease costs *because two vessels have to be used* which increases delays and operating expenditures

Note that the italicized statements about requiring at least two replacement vessels is only true in cases where the larger vessel would be loading/unloading its entire cargo at a non-depth constrained Port Everglades. Typically, this would be the case for point-to-point bulk services only. The typical container vessel (at least ones large enough to require increased channel depth) is on a liner service that only loads/unloads a portion of their cargo at any given port on its rotation. For these container vessels, this alternative would take the form of transshipping all or a portion of their Port Everglades-bound cargo at another port onto a smaller (but less efficient) vessel.

Page 66, 6. Light-Loading Vessels. *This measure would limit the capacity of the vessels that could enter the port*.

Suggest rewording italicized sentence to "This measure would limit the ability of vessels entering the port to load to their full capacity.

Page 66, 7. Lightering Vessels. The two main commodities that would require lightering at Port Everglades are *containers and petroleum. Petroleum lightering is a more common practice in the Gulf of Mexico and not in the Atlantic.*

The concept of off-shore lightering is typically not applied to container vessels. Transshipment of containers to smaller vessels typically occurs at alternative transshipment ports (such as Jamaica or Manzanillo).

Also, please note that petroleum lightering is common in the north Atlantic, and occurs most notably in the Delaware Bay, New York Harbor, Long Island Sound, Narragansett Bay, and Chesapeake Bay. Lightering is typically done at a designated anchorage or protected off-shore or near-shore area however, none of which are available in close proximity to Port Everglades.

Also note that the larger vessel that is lightered is still required to enter the harbor, as is the smaller lightering vessel, resulting in congestion problems from additional vessels and safety issues associated with the larger tankers, similar to those problems discussed for container vessels under 6. Light Loading .

Page 66, 8. Off-Shore Petroleum . This measure would build an off-shore facility for the petroleum vessels. ... This measure meets objective 2 to *decrease transportation costs.*

While this measure might decrease the waterborne leg of transportation costs, it would significantly increase the landside leg, and very likely increase total transportation costs, as well. There is also an increased environmental risk of oil transfers offshore.

Page 66: 9. Alternate Rail

The paragraph incorrectly indicates that there are no rail cars designed to transport petroleum related products. While it is accurate that some of the refined petroleum products entering Port Everglades are not normally shipped by rail, the primary reason that use of rail to provide petroleum products to south Florida is not feasible is due to the volumes required and the lack of rail infrastructure to deliver those volumes.

Page 76, Plan NS-3: Clear Bearthed Vessels

Misspelling. "Bearthed" should be "Berthed"

Plan NS-6: Light-Loading Vessels
Carrying less cargo per transit equates to increased transportation costs due to increased transit for delivery of the goods. As such, Plan NS-6 was eliminated as a viable option.
Plans NS-4 (Trucking), NS-7 (Lightering Vessels), and NS-8 (Off-Shore Petroleum) were carried into the next level of detailed analysis and are evaluated in section 4.7.1.

The logic for inclusion and exclusion is not consistent. If the rationale for the elimination of Plan NS-6 is increased transportation costs, then Plans NS-4, NS-7 and NS-8 should also be eliminated for the same reason. Trucking increases transportation costs by landing cargo at a less cost effective port location. Lightering increases transportation costs due to a second cargo handling and use of an additional vessel. Off-shore petroleum increases transportation costs due to the additional construction costs of vessel unloading and piping/pumping infrastructure.

Page 82: Disposal Options

The temporary disposal site for dredged material between Slips 2 and 3 no longer exists. Recommend deletion of the last 2 sentences of that section and replace it with: "A temporary site for upland material not suitable for offshore disposal that could be staged, dried, and then transported offsite for landfill capping or other use is located on the port in the southwest corner of Southport. That site has been used by the port for maintenance dredging material."

Page 82, 3rd paragraph. An Environmental Assessment (EA) is being prepared in coordination with the Environmental Protection Agency (EPA) to address the ODMDS expansion. The final report is scheduled to be completed winter 2013.

Is an incomplete DMMP without an approved disposal area sufficient to accommodate project dredge volumes and O&M quantities considered sufficient for approval of the Feasibility Report? Since upland sites are no longer available, what is the alternative if the ODMDS expansion is not approved? Has that possibility been factored into the cost risk analysis?

Lightering Plan: Lightering vessels is when part of the commodity is off-loaded outside of the port onto smaller vessels for entry into shallower ports. The two main commodities that would require lightering at Port Everglades are containers and petroleum. *Petroleum lightering however, is more common practice in the Gulf of Mexico and not in the Atlantic*, and is thus further evaluated

See earlier comment regarding Atlantic Coast lightering.

Page 83: Utility Relocations in Port Everglades

Revise the first sentence to "Utility investigations indicate that Florida Power and Light (FPL) cables are laid on the existing channel bottom along the SAC." FPL has confirmed that the cable across the IEC was removed in 1987.

Page 90-105, 4.8 FINAL ARRAY OF ALTERNATIVE PLANS

General Comment: We find this section of the report to be very confusing and unnecessarily complicated. Specific concerns include the following:

- **The structural measures were grouped into six different plans based on structural characteristics, environmental impacts, and *economic units*.** What is meant by an "economic unit"? Does this mean project segments that are independent and so should be incrementally justified?
- Table 24 is understandable, however, the un-numbered Figure on page 92 is not, without additional description. The text provided on Page 91 confuses more than it elucidates.
- Page 94. What is the intent of the list of features beginning with Plan 1B, some of which are **highlighted** and others light shaded? Are the light shaded items not included in this (and later) alternatives? If so, please state at the beginning of this section.

Page 106, 4.9.1 Environmental Operating Principles

"The USACE Environmental Operating Principles (EOP's) were developed in ... These EOP's were revisited in 2012 with more emphasis on proactively *implimenting* these *principals*."

Italicized words are misspelling and wrong word. Should be "implementing" and "principles"

Page 106, 5. Consider the environment in employing a risk management and systems approach throughout life *cylcles* of projects and programs.

Italicized word should be "cycles"

Page 108, 5.1 2nd paragraph, With each foot of increased depth at Port Everglades, containership costs increase as more cargo is moved per call. However, the gross cargo volume increases at a greater rate than the increased voyage related costs, and therein lies the benefit to deepening, as mentioned before.

Suggested rewrite, "With each foot of increased depth at Port Everglades, the costs per containership increase as more cargo is moved per call. However, the gross cargo volume increases at a greater rate than the increased voyage related costs, resulting in a lower cost per TEU transported and fewer ships are required to deliver the same total volume of cargo to the Port. This is the source of the deepening benefits."

Pages 113 and 116: Table 29 and Table 30

The Average Annual TCS Benefits of $24,480,000 for the TSP 48'+Widening alternative in Table 29 doesn't match the AAEQ Benefits of $24,820,000 in Table 30. These should be the same.

Page 114, Table 29: Alternative Depths Analysis

How is it that Interest During Construction (IDC) increases as a percentage of total first costs as depth increases, from 7.8% (46') to 12.9% (51'). Is the length of the construction period consistently greater as depth increases?

Why are there no TCS benefits beyond 49 feet? What is the maximum vessel operating draft restriction that gives rise to this result? If the TPV of TCS is the same for 49 – 51 feet, how is it that the Avg. Annual TCS benefits increase (albeit slightly)?

Page 116: Table 30

The B/C ratio of 1.59 and AAEQ Benefits of $24,820,000 are inconsistent with the 1.57 and $24, 480,000 on page 73 of the Economic Appendix.

Page 119, Table 33: Construction Phasing

How is the 8 year construction start phasing consistent with the project base year of 2017 cited earlier in the report? Schedule should be aligned with the ACOE target for completion of construction in 2017.

Page 121, 7.1 OPERATIONS AND MAINTENANCE CONSIDERATIONS, 2nd paragraph, The increase in maintenance costs over the existing O&M was determined using FY 11 costs and a 4.375% interest rate over the 50-year period of analysis. The existing project has an AAEQ cost of $183,106 and the proposed project AAEQ cost is $218,385. The annual O&M costs increases by $35,279. This increase in cost is based on the increase in material needing to be removed from the channel. The existing project needs approximately 217,000 cubic yards removed every 10 years while the proposed project will need approximately 274,400 cubic yards removed.

The calculation of incremental O&M costs appears to be out of date, based on prior years' price levels and discount rates. The costs cited for incremental O&M are not consistent with totals shown in Table 29.

Page 149 11.0 REFERENCES

The list of references seems very short and incomplete. Missing (among others) are the most recent Port Everglades Master/Vision Plans.

Draft Environmental Impact Statement (EIS) Comments

1. The diameter threshold for coral relocation should be 10cm in accordance with typical permitting criteria. The EIS alternately states the diameter threshold for coral relocation is 10 cm or 25 cm. It is recommended that all corals 10 cm in diameter or greater be relocated in accordance with typical permitting criteria.

2. Downslope reef impacts should be included in the EIS if clamshell dredging is an option for the third reef. The EIS does not account for downslope reef impacts that may occur during dredging of the upper part of the reef. Discussions with USACE staff indicate that downslope reef impacts were initially considered; they were ultimately excluded from the EIS analysis based on monitoring reports from the Miami dredging project demonstrating no downslope impacts from the use of a suction dredge. However, the EIS provides for clamshell dredging as a possible construction methodology; therefore, the potential for downslope reef impacts should be addressed unless the EIS is revised to specify the use of a suction dredge. In addition:

   - Other federal agencies and/or local regulatory/resource agencies may disagree with USACE's analysis of the extent of hardbottom/reef habitats (Section 4.4.2.2 of the Draft EIS), and which impacts could result in additional compensatory mitigation (possibly, rock/rubble habitat within the existing federal channel). There may be large rock/rubble features within the existing channel that are colonized by corals; discernible via sidescan sonar or other means. The loss of these hardbottom habitats should be accounted for, and if they are impacted, mitigation should be provided.

   - Broward County Natural Resources Planning and Management Division conducted an independent review of the project's reef impact assessment based on the GIS habitat classification mapping and anticipated project impact area. The outcome of this review essentially verified the project impacts are consistent with what is shown and discussed in the Feasibility Study and DEIS. However, as discussed above the potential for downslope reef impacts was apparently discounted by the USACE in the DEIS and needs to be discussed in the development of the final EIS document.

3. Direct and indirect impacts that may occur from turbidity/sedimentation as a result of construction practices are not fully accounted for in the EIS. The use of best management practices is mandated in the EIS to ensure proper control of turbidity / sedimentation and the USACE definition of environmental success for this project is for indirect impacts to be both minimal and indiscernible (July 23, 2013 1:00 pm public meeting). However, historic long-shore currents in the project vicinity and tidal changes at the inlet will make sediment and turbidity control difficult. Staff recommends that a contingent mitigation plan be

developed to help ensure mitigation requirements that may result from unintentional impacts are accounted for, and budgeted, in the planning phases of the project.

4. A detailed pre-construction seagrass survey should be performed to ensure that seagrass impacts are properly identified and mitigated. The EIS includes assumptions regarding impacts to seagrasses based on seagrass surveys performed by various entities from 1999 to 2009. These historic surveys may not be representative of current conditions as it is common for seagrass beds to change shape and size over time. We encourage an updated survey be completed so that the precise extent of impacts, and resulting potential mitigation burden on the ongoing West Lake Park (WLP) habitat improvement project, can be determined prior to construction. A contingency plan for mitigation should also be provided in case WLP cannot accommodate all of the required seagrass mitigation.

5. The estimates for mitigation acreages are based on assumptions and the methodology is not fully documented in the EIS. Required mitigation acreage tables for seagrass & mangrove impacts do not include the necessary Uniform Mitigation Assessment Method (UMAM) worksheets. Discussion with USACE staff at the July 23 public meeting indicated that the preliminary estimates were based on historic knowledge from permitting agencies and that a detailed analysis with UMAM worksheets and backup documentation would be performed in a later phase. The wetland delineation for the mangrove habitats in the impact area and adjacent areas (Section 3.5.6 in the Draft EIS) is out-of-date. Broward County recommends these areas be delineated as soon as possible in order to better determine the precise extent of impacts, and resulting potential mitigation burden on the ongoing WLP habitat improvement project.

6. The cost estimates for coral mitigation are not consistent with costs incurred by the County for similar projects. The mitigation plan (Table 8, page 33) lists the cost for artificial reef creation, without coral transplantation, as $588,524 per acre. In 2003, Broward County implemented a shallow water reef creation project without coral transplantation at a cost of $675,000/acre. Staff recommends consulting with local marine contractors to obtain a more accurate estimate to help ensure mitigation requirements may be properly accounted for, and budgeted, in the planning phases of the project. A more likely range of per acre mitigation costs is between $800,000 and $1 million. Staff is aware of a project currently underway in St. Lucie County where the unit cost is approximately $833,000/acre.

7. The HEA input parameters are inconsistent with typical resource recovery. The HEA inputs assume that the damaged reef will recover to a 15% level of service in 50 years and the artificial boulder mitigation will recover to a 100% level of service. However, the proposed dredging project will remove the reef framework and in the case of the outer reef, create rubble bottom, therefore making full recovery unlikely. In addition, mature artificial reefs do not provide the same services as a natural reef. Therefore, staff recommends changing

recovery time inputs for outer reef impacts from 50 years to "in perpetuity" and adjusting recovery service level inputs for boulder mitigation to less than 100%.

8. Coral Reef mitigation sites may inhibit future County projects. The Mitigation Requirements for Hardbottom Resources Associated with Port Everglades Harbor Navigation Improvements (page 36, section 6.4.2, 2nd paragraph) contemplates utilizing existing artificial reef sites permitted by Broward County's Natural Resource Planning and Management Division (NRPMD). Obtaining permits for these existing artificial reef sites required considerable effort by NRPMD; therefore, staff is concerned that their use by this project may entail the repetition of past permitting efforts in order to obtain new mitigation sites and/or possibly require the relocation of previously required mitigation. In addition, an alternative (Figure 8, page 39) proposes the use of sand borrow sites for mitigation which may adversely affect future beach nourishment projects. Staff recommends that the USACE coordinate with local and state regulatory agencies to identify additional sites for proposed mitigation.

9. The EIS uses a Discount Rate of 0% rather than the previously agreed upon 3%. The Draft Comprehensive Mitigation Plan (Appendix E-2, page 23, section 4.6.3) uses a discount rate of 0% with the explanation that no discounting should occur on a federal water resources project as indicated in OMB circulars A-4 and A-94. Staffs review of the referenced circulars and "Economic and Environmental Principles and Guidelines..." found no mention of the required 0% discount rate. Rather 3% and 7% were used often as examples of acceptable discount rates. The National Oceanic and Atmospheric Administration (NOAA) (*1999 Discounting and the Treatment of Uncertainty in Natural Resource Damage Assessment. Damage Assessment and Restoration Program, Damage Assessment Center, Resource Valuation Branch. Technical Paper 99-1. Silver Spring, MD, February*) uses a discount rate of 3%. This represents the public's preference toward having a restoration project in the present year, rather than waiting until next year. In meetings for previous drafts of the EIS, the USACE agreed that 3% was appropriate while some agency staff argued for 6%.

10. Recommendation for Hardbottom/Reef Mitigation. The USACE-preferred type of mitigation proposed for impacts to hardbottom and reef habitats may not be the preferred option by other federal agencies or local regulatory/resource agencies (Section 6.2, Item 8, of the CMP/ICA). The type and amount offered by USACE appears to have the best benefit-to-cost ratio but this evaluation may be based on an underestimate of the costs for mitigation per acre as outlined in comment #6 above. Broward County, as the local project sponsor, may be liable for any costs beyond those of the "Best Buy" option if another option is selected, including that presented by NOAA/NMFS in the DEIS.

    - It is Broward County's opinion that portions of the presented NOAA/NMFS mitigation plan in the DEIS may not be considered appropriate in-kind project mitigation; however, some of the concepts could be considered in the final mitigation plan wherein various mitigation options are considered. It is our recommendation that the final selected coral mitigation strategy include a blend of various mitigation options, such as, artificial reef creation using rock/boulder and modules along with coral transplants; artificial reef placement on the existing "tire reef"; the potential restoration of historic grounding sites using coral transplants; and the possibility of including a test site for coral propagation from in-water and land-based nurseries.

Minor Error and Omissions

List of acronyms needs to be expanded since there are more than noted above that are not included in the Acronym List including TEU's, FONSI, TTS, NAAQS, DERA and ROI

Reference to numbers of vessels (baseline and projected) are inconsistent throughout the document

Page XV, List of Figures

Figure 39 is not listed on the index. Figure 56 is on page 127 not page 128.

Page 81, Figure 38

Legend should indicate size of areas

Page 105, 3.6.1.3

Suggest a figure here to show areas 1-7

Page 115, Last Paragraph

Should include Strombus gigas since it is a protected CITES II species.

Page 118, Section 3.6.4.3

Paragraphs above and below "3.6.4.3" are the same

Page 127, Figure 56

Figure is not labeled

Page 145, Section 3.7.3.14, sentence at top of page

Delete "sand" add period and begin new sentence with "Dustan".

Page 145, Section 3.7.3.14, 4th sentence

"Cogeners" is more commonly spelled "congeners"

Page 145, last sentence

"was" should be "were"

Page 148, Section 3.9.2, Second Paragraph, 1st sentence

"Count" should be "County"

Page 148, Section 3.9.2

Text is wrong, figure is right. Should be Figure 63.

Page 148, Section 3.9.2

Text is wrong, figure is right. Should be Figure 64.

Page 195, 1st paragraph, last sentence

Mentions sea turtles in the crocodile discussion, should be in 4.5.5

Appendix E, Page 33, Table 8

Typo on the "all others habitats row. "0.0 should be 0.0*.

Appendix E, Page 33/34, Table 8 & 9

Both tables contain the same information

Appendix E, Page 41, 2nd paragraph, last sentence

Should provide reference to appendix

Appendix E-2

The legends for Figures 1-2 should indicate acreages

Appendix E-2, Page 30, Table 14

"Vales" should be "Values"

Appendix J

Note title page, author, date, and pages are not numbered

Appendix J, Section 1.6

Stops mid-sentence

Sub-Appendix E

No author shown on title page

Sub-Appendix G

No author or date shown on title page

Acronyms are not defined

Sub-Appendix G, Title Page: Estimate for National Economic Development Plan of 48'

Referenced 1816 days which equals 4.97 years for the project, DEIS indicates project will last 3 years.

Engineering Appendix Comments

Need to ensure that the bulkhead cost in the without and with-project conditions are accurate. The Port will be implementing several bulkhead related projects prior to the with-project condition and those cost should not be included in the overall cost estimate for the project.

Page A-10: Figure A-2 Port Layout and Berthing

The map in this figure is out of date and should be replaced with our current port map.

Page A-12: Paragraph 19

In the 5th line, the FAWN station is 7 miles "west" of the port, not "east."

Page A-29 and A-30: Paragraph 68

The last maintenance dredging occurred in 2013, not 2005. The year and quantity of material from that dredging should also be added to Table A-8.

Page A-121: Table A-19

While the ACOE may want to include this table to show a consecutively constructed project, should also add a timeline that shows the sequencing for project construction being completed within two years as was indicated during the public meetings

Pages A-124 and A-125: Figure A-79

While the ACOE may want to include this Figure to show a consecutively constructed project, should also add a Figure with a timeline that shows the sequencing for project construction being completed within two years as was indicated during the public meetings.

Page 101, Section 3.8.4

This should be revised to reflect that the only FPL cable is the one located in the Southport Access Channel.

Pages 120/121, Section 4.4

This section and associated tables should be revised to indicate a non-sequential more realistic implementation schedule that aligns with the with-project condition date of 2017.

Socioeconomics Appendix Comments

Section 4.1: Intermodal Container Transfer Facility - last sentence.

Comment: Is it necessary to take the most restrictive view of the potential impact of the ICTF on future Port Everglades cargo? The ICTF will provide a substantial competitive advantage to Port Everglades. Construction is ongoing, so there is no question of whether the facility will be operational in the base year. The Port and FEC have projections for future cargo movements. These projections should be included in the analysis.

Section 5.1 Commodity Forecast Methods and Assumptions – first paragraph

Comment: South Atlantic ports used in the analysis should be identified.

Section 6.1 Future Without-project Vessel Fleet – first paragraph, last sentence

Comment: Has the Port been consulted concerning the size of future cruise ships? As one of the world's premier cruise ports, Port Everglades often homeports the newest vessels in the world's fleet. The trend is for these vessels to be larger than their predecessors. The port is also improving landside facilities to accommodate more very large cruise ships. It may be the case that the future fleet will include a larger proportion of very large container ships than are in the existing fleet.

Section 6.1 Future Without-project Vessel Fleet – second paragraph

Comment: This paragraph could also be interpreted to indicate that Port Everglades will lose containership services and cargo in the without-project condition. The loss of services and cargo under without-project conditions is the logical result of larger vessels and alternative ports with deeper channel. This should be addressed in the analysis.

Section 7.1 Description of Final Array of Alternatives – Planning Objective #3

Comment: Planning objective #3 reads as if the objective is to increase channel safety and maneuverability for future vessels. It should be noted that all analyses are conducted on the existing fleet and not on larger future vessels, which and will likely use the port in the future under with-project conditions.

Section 8.1 Transportation Cost Savings – last sentence

Comment: Tug cost and fuel cost reductions identified earlier in the document are consistent with ER 1105-2-100. They should be included as transportation cost savings. Further, the spreadsheet models and economic analysis for these additional benefits that was provided to the U.S. Army Corps of Engineers on June 20, 2013 should immediately begin the review process so that these additional benefits may be included in the Benefit Cost Ratio as soon as possible.

Section 9 Future With-project Fleet Forecast – containership bullets

Comment: A table showing what's in and what's out (as described in the bullets) would help the reader understand and compare the fleet composition for each trade route.

Section 10 Evaluation of Alternatives via HarborSym – second sentence

Comment: This sentence is incorrect. HarborSym does not calculate total transportation costs. HarborSym calculates a sub-set of total transportation costs – for example, tug assist costs are not included, which are a component of total transportation costs.

Section 10.2 Modeling Assumptions – Table 31

Comment: Please explain how the values in Table 31 were calculated and how they are used in the model. For example, does every vessel call on the ECUS-WCSA route arrive and depart with 24.7% empty TEUs and 6.5% vacant slots? If so, what constrains the carrier to maintain these averages?

Section 10.3 Model Setup and Calibration – last paragraph

Comment: What is "Existing Condition ()". Is that a typo?

Section 10.3.1 Vessel Types – third paragraph

Comment: Is EGM 11-05 the most recent version of operating costs? Also, summary values such as hourly operating costs by class should not be proprietary because they cannot be traced back to a single user. It would be helpful to the reader, if a table of costs were provided so that economies of scale could be pointed out ($/TEU/thousand miles, for example).

Section 10.5 Model Outputs – first paragraph

Comment: Suggest changing "total transportation costs" to "HarborSym-transportation costs" to avoid the incorrect presentation of HarborSym-calculated costs as total costs.

Section 11 National Economic Development Benefits – first paragraph

Comment: The discussion of NED benefits should be caveated by stating that tug assist reduction benefits and fuel consumption reduction benefits are not included in the HarborSym analysis.

Section 12 Regional Economic Development Benefits – first paragraph

Comment: Some mention should be made concerning the temporal nature of these benefits. Are they projected to occur only during construction? Two years, three years, etc?

Section 13 Sensitivity and Scenario Analyses – first paragraph

Comment: The baseline analysis is very conservative in its approach and assumptions, therefore why are only more conservative assumptions used for the sensitivity analyses? Suggest including additional cargo in without-out and with-project conditions due to ICTF, and loss of container services and cargo under without-project condition associated with increased services and cargo under with-project conditions.

Dredged Material Management Plan Appendix Comments

Page 9: First paragraph

Update economic impact sentence to read "With an annual economic impact of almost $25.7 billion and 201,700 Florida jobs, the port offers great value to the community."

Page 11: Figure 1

Update waterborne commerce tonnage to FY 2012 data. Also suggest deleting the 2007 commoditioes and passengers pie chart since it combines different units of measure (passenger counts and cargo tonnage) in the same graph. Suggest using data in table format from the Port FY Waterborne commerce chart that shows tonnage and passenger counts separately.

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
NAVAL SURFACE WARFARE CENTER
CARDEROCK DIVISION

9500 MACARTHUR BOULEVARD
WEST BETHESDA, MD 20817-5700

IN REPLY REFER TO:
3354
Ser 71/08019
20 Feb 08

From: Commander, Naval Surface Warfare Center, Carderock Division
To: Planning Division, Plan Formulation Branch, Department of The Army, Jacksonville District Corps of Engineers, P.O. Box 4970, Jacksonville, FL 32232-0019

Subj: PORT EVERGLADES ENTRANCE CHANNEL ALIGNMENT

Ref: (a) Ltr of 18 Jul 07, Jacksonville District Corps of Engineers, Plan Formulation Branch

Encl: (1) Sketch of the Navy Restricted Area

1. Reference (a) requested a review and response to the proposed Army Corp of Engineer's development of an Integrated Feasibility Study and Environmental Impact Statement for improvements at the Port Everglades Federal navigation project. The Naval Surface Warfare Center Carderock Division (NSWCCD), appreciates the opportunity to provide comment on the proposed project and alternatives.

2. These alternatives, all of which shift the entrance channel/shipping traffic south of the current alignment, are unacceptable to the Navy and directly impact our operations, both from a vessel safety stand point and the direct potential for the destruction of our facilities' underwater infrastructure.

3. All of the proposed alternatives have vessel traffic transiting directly into the Navy's Restricted Area. This action, if implemented, creates potential vessel conflicts between commercial and U. S. Navy vessels. Enclosure (1) provides an illustration of the location of the Navy's restricted area and the Naval Surface Warfare Center Carderock Division-South Florida Testing Facility (NSWCCD-SFTF) range (green box) in relationship to the proposed options.

4. During testing operations, naval vessels can and do operate throughout the restricted area. As apparent, the proposed

Subj: PORT EVERGLADES ENTRACE CHANNEL ALIGNMENT

option(s) places commercial vessel traffic in opposition to naval vessels operating within the restricted area thus jeopardizing the safety of both vessels.

5. As discussed in Reference (a), the Navy exercises jurisdiction over these waters as provided for in 33CFR § 334.580. Jurisdiction over this area is intended to protect the Navy's submerged infrastructure and assets. Infrastructure, consisting of numerous cable runs, multitude of underwater sensors and other structures are all required for the successful and safe operation of the facility. The Federal regulations further state that in the naval restricted area "anchoring, trawling, dredging, or attaching any object to the submerged sea bottom shall be prohibited…" Hence, the proposed alternatives involving dredging and/or placement of objects on the ocean's bottom within the restricted area would directly and severely impact the operations of this facility with the potential destruction of the infrastructure.

6. In summary, due to the potential of vessel safety issues and the destruction of our infrastructure, the NSWCCD-SFTF can not endorse any of the three proposed options. Your cooperation in this matter is respectfully requested. If you would like to discuss this issue in more detail please contact our South Florida Test Facility Site Director, Douglas Garbini, at (954)926-4005, or douglas.garbini@navy.mil.

MARK W. THOMAS

U.S. Department of Homeland Security
United States Coast Guard

Commander
United States Coast Guard
Sector Miami

100 MacArthur Causeway
Miami Beach, FL 33139
Staff Symbol: spw
Phone (305) 535-8724
Fax: (305) 535-8740

16670 /07-1762
January 23, 2008

Marie G. Burns
Acting Chief, Planning Division
Jacksonville District Corps of Engineers
Department of the Army
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Ms. Burns:

I am writing in response to your letter dated November 5, 2007. The U.S. Coast Guard is charged with ensuring the safe navigation of vessels and the protection of the environment. Having reviewed the proposed entrance channel alignments for Port Everglades, Florida, I am providing the following preliminary comments for the Feasibility Study that will be included in the National Environmental Protection Agency document:

1. <u>Outer Entrance Channel Alternative 1</u>

   USACE comment: "...would avoid dredging but would require placement of buoys/markers at the entrance of the gap and would require two 90-degree turns to access the existing entrance channel. This approach may also require the dredging of a turning basin to safely allow the incoming ships to enter the channel."

   USCG comment: The two required 90-degree turns would elevate the navigational risk for deep draft vessels that routinely call at this port to an unacceptable level. The narrow corridor and short turning basins this channel would create would restrict maneuverability thus increasing the risk of grounding.

2. <u>Outer Entrance Channel Alignments #2 and #3</u>

   USACE comment: "...would require direct impacts to the 2nd and 3rd hardground relic reef terraces by dredging, as well as placement of channel alignment buoys/markers to mark the entrance channel for deep draft vessel access."

   USCG comment: The addition of two turns in alternative #2 and one turn in alternative #3 also elevate the navigational risk for deep draft vessels that routinely call on the port. Strong North/South prevailing currents, often times unpredictable in terms of force, coupled with greater exposure to other risk factors such as submerged breakwaters, spoil areas, small craft congestion and Naval restricted areas, make these alternatives problematic.

3. <u>Outer Entrance Channel Alignment #4</u>

USACE comment: "…would avoid dredging but would require placement of channel buoys/markers at the entrance and on the transit route. This alignment would require the transit of the vessels entering the port for up to three miles from the southern reef gap, northward between the 2nd and 3rd relic reef terraces, to the current entrance channel alignment, and then a 90-degree left turn into the entrance channel. This turn would probably require widening to allow safe transit into the existing entrance channel."

USCG comment: Again the two required 90-degree turns would elevate the navigational risk for deep draft vessels that routinely call at this port to an unacceptable level. This option would require vessels to transit the entire Naval restricted area and lengthen their exposure to the reefs.

Other hazards may also arise with the construction of the proposed liquefied natural gas deepwater port, and from larger vessels that will soon begin calling on Port Everglades. For example, Royal Caribbean is building the world's largest cruise ship that will measure 1,180 ft in length, displace 220,000 tons and carry 8000 passengers/crew. This is one of nine new cruise ships scheduled for delivery in 2009. Many, if not all, of these ships will visit Port Everglades.

In regards to the installation and servicing of navigational aids that would be needed for the new channel alignments, expenses could reach upwards of $1.3 million for initial placement and approximately $42,000 for recurring costs.

My overall concern is to help prevent marine accidents that may ultimately cause harm to life and/or the environment. At this time I cannot recommend any of the aforementioned alternatives. For further info please contact LT Chaning Burgess - Waterways Division Chief at 305-535-8724 or by email at chaning.d.burgess@uscg.mil.

Sincerely,

KARL L. SCHULTZ
Captain, U.S. Coast Guard
Captain of The Port

Planning Division
Environmental Branch

SEP 1 1 2007

Ms. Janet Llewellyn
Florida Department of Environmental Protection
Division of Water Resources Management
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Dear Ms. Llewellyn:

In accordance with regulations pertaining to the National Environmental Policy Act (NEPA) Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. The purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study.

Cooperating agency status involves actions and responsibilities beyond that normally associated with a commenting or permitting agency. In the case of Port Everglades, we believe that cooperating agencies shall assist U.S. Army Corps of Engineers, (Corps) authors and contractors in developing language for the IEIS, reviewing and providing edits to draft language and providing comments on those sections of the IEIS where an agency has either regulatory authority or specialized expertise (CEQ Regulations §1051.6(a)2). This review and editing process will take place earlier than the typical review and comment associated with a Draft EIS. As part of the Port Everglades external Project Delivery Team, your staff has been providing review and comments on the environmental studies that the Corps is using to develop the impact assessments and mitigation plans for the IEIS. We are now taking this opportunity to formalize your participation in the NEPA process as a cooperating agency. If you choose not to become a cooperating agency, we will continue to coordinate as we have done in the past.

The formulation of the project, alternatives and mitigation will be in accordance with Engineer Regulation ER 1105-2-100 and will fully consider a range of environmental, economic and social factors. Your participation as a cooperating agency will help us fully consider the views, needs and benefits of competing interests. For additional information on becoming a cooperating agency, please see the enclosed "Rights and Responsibilities of Lead and Cooperating Agencies" (Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, Council on Environmental Quality, 1981). The complete list of Forty FAQs can be found at http://www.nepa.gov/nepa/regs/40/40p3.htm.

We would appreciate a response to this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Ms. Terri Jordan, Biologist, at 904-232-1817 or Terri.L.Jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Acting Chief, Planning Division

Enclosure

Copies Furnished:

Mr. Martin Seeling, Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems, 3900 Commonwealth Boulevard, MS 300, Tallahassee, Florida 32399
Mr. Michael Barnett, Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems, 3900 Commonwealth Boulevard, MS 300, Tallahassee, Florida 32399

Jordan/CESAJ-PD-EC/1817/als 6 Sep 07
Dugger/CESAJ-PD-E
Powell/CESAJ-PD-PN
Schwictenberg/CESAJ-PD-P
Ross/CESAJ-DP-I
Scarborough/CESAJ-DP-C
Burns/CESAJ-PD

L: group/pdec/Jordan/Cooperating Agency Letters

Planning Division
Environmental Branch

SEP 1 1 2007

Mr. Paul Souza
Field Supervisor
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, Florida 32960-3559

Dear Mr. Souza:

In accordance with regulations pertaining to the National Environmental Policy Act (NEPA) Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. The purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study.

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The formulation of the project, alternatives and mitigation will be in accordance with Engineer Regulation ER 1105-2-100 and will fully consider a range of environmental, economic and social factors. Your participation as a cooperating agency will help us fully consider the views, needs and benefits of competing interests. For additional information on becoming a cooperating agency, please see the enclosed "Rights and Responsibilities of Lead and Cooperating Agencies" (Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, Council on Environmental Quality, 1981). The complete list of Forty FAQs can be found at http://www.nepa.gov/nepa/regs/40/40p3.htm.

We would appreciate a response to this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Ms. Terri Jordan, Biologist, at 904-232-1817 or Terri.L.Jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Acting Chief, Planning Division

Enclosure

Copies Furnished:

Mr. Spencer Simon, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, Florida 32960-3559
Mr. Jeff Howe, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, Florida 32960-3559

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Ross/CESAJ-DP-I
Scarborough/CESAJ-DP-C
Burns/CESAJ-PD

L: group/pdec/Jordan/Cooperating Agency Letters

Planning Division
Environmental Branch SEP 1 1 2007

Mr. Miles Croom
National Marine Fisheries Service
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5511

Dear Mr. Croom:

In accordance with regulations pertaining to the National Environmental Policy Act (NEPA) Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. The purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study.

Cooperating agency status involves actions and responsibilities beyond that normally associated with a commenting or permitting agency. In the case of Port Everglades, we believe that cooperating agencies shall assist U.S. Army Corps of Engineers, (Corps) authors and contractors in developing language for the IEIS, reviewing and providing edits to draft language and providing comments on those sections of the IEIS where an agency has either regulatory authority or specialized expertise (CEQ Regulations §1051.6(a)2). This review and editing process will take place earlier than the typical review and comment associated with a Draft EIS. As part of the Port Everglades external Project Delivery Team, your staff has been providing review and comments on the environmental studies that the Corps is using to develop the impact assessments and mitigation plans for the IEIS. We are now taking this opportunity to formalize your participation in the NEPA process as a cooperating agency. If you choose not to become a cooperating agency, we will continue to coordinate as we have done in the past.

The formulation of the project, alternatives and mitigation will be in accordance with Engineer Regulation ER 1105-2-100 and will fully consider a range of environmental, economic and social factors. Your participation as a cooperating agency will help us fully consider the views, needs and benefits of competing interests. For additional information on becoming a cooperating agency, please see the enclosed "Rights and Responsibilities of Lead and Cooperating Agencies" (Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, Council on Environmental Quality, 1981). The complete list of Forty FAQs can be found at http://www.nepa.gov/nepa/regs/40/40p3.htm.

We would appreciate a response to this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Ms. Terri Jordan, Biologist, at 904-232-1817 or Terri.L.Jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Acting Chief, Planning Division

Enclosure

Copies Furnished:

Mr. Pace Wilber, Atlantic Branch, Charleston (F/SER47), Southeast Regional Office, NOAA Fisheries, Post Office Box 12559, Charleston, South Carolina, 29422-2559
Ms. Jocelyn Karazsia, NOAA Fisheries –HCD, 400 North Congress Avenue, Suite 120, West Palm Beach, Florida 33401

Jordan/CESAJ-PD-EC/1817/ TLJ 10 Sep 07 / als 6 Sep 07
KN Dugger/CESAJ-PD-E
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Scarborough/CESAJ-DP-C
Burns/CESAJ-PD

L: group/pdec/Jordan/Cooperating Agency Letters

Planning Division
Environmental Branch

SEP 1 1 2007

Mr. David Bernhart
NOAA Fisheries, Protected Resources Division
263 13th Avenue South
St. Petersburg, Florida 33701

Dear Mr. Bernhart:

In accordance with regulations pertaining to the National Environmental Policy Act (NEPA) Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. The purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study.

Cooperating agency status involves actions and responsibilities beyond that normally associated with a commenting or permitting agency. In the case of Port Everglades, we believe that cooperating agencies shall assist U.S. Army Corps of Engineers, (Corps) authors and contractors in developing language for the IEIS, reviewing and providing edits to draft language and providing comments on those sections of the IEIS where an agency has either regulatory authority or specialized expertise (CEQ Regulations §1051.6(a)2). This review and editing process will take place earlier than the typical review and comment associated with a Draft EIS. As part of the Port Everglades external Project Delivery Team, your staff has been providing review and comments on the environmental studies that the Corps is using to develop the impact assessments and mitigation plans for the IEIS. We are now taking this opportunity to formalize your participation in the NEPA process as a cooperating agency. If you choose not to become a cooperating agency, we will continue to coordinate as we have done in the past.

The formulation of the project, alternatives and mitigation will be in accordance with Engineer Regulation ER 1105-2-100 and will fully consider a range of environmental, economic and social factors. Your participation as a cooperating agency will help us fully consider the views, needs and benefits of competing interests. For additional information on becoming a cooperating agency, please see the enclosed "Rights and Responsibilities of Lead and Cooperating Agencies" (Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, Council on Environmental Quality, 1981). The complete list of Forty FAQs can be found at http://www.nepa.gov/nepa/regs/40/40p3.htm.

We would appreciate a response to this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Ms. Terri Jordan, Biologist, at 904-232-1817 or Terri.L.Jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Acting Chief, Planning Division

Enclosure

Copies Furnished:

Mr. Bob Hoffman, NOAA Fisheries, Protected Resources Division, 263 13th Avenue South, St. Petersburg, Florida 33701
Ms. Audra Livergood, NOAA Fisheries, Protected Resources Division, Miami Field Office, 11420 North Kendall Drive, Suite 103, Miami, Florida 33176

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Ross/CESAJ-DP-I
Scarborough/CESAJ-DP-C
Burns/CESAJ-PD

L: group/pdec/Jordan/Cooperating Agency Letters

Planning Division
Environmental Branch SEP 1 1 2007

Ms. Stephanie Bailenson, Director
Florida Department of Environmental Protection
Office of Coastal and Aquatic Managed Areas
3900 Commonwealth Boulevard
Douglas Building MS 235
Tallahassee, Florida 32399-3000

Dear Ms. Bailenson:

In accordance with regulations pertaining to the National Environmental Policy Act (NEPA) Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. The purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study.

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We would appreciate a response to this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Ms. Terri Jordan, Biologist, at 904-232-1817 or Terri.L.Jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Acting Chief, Planning Division

Enclosure

Copies Furnished:

Ms. Ellen McCarron, Assistant Director, Florida Department of Environmental Protection, Office of Coastal and Aquatic Managed Areas, 3900 Commonwealth Boulevard, Douglas Building, MS 235, Tallahassee, Florida 32399-3000
Ms. Chantal Collier, Florida Department of Environmental Protection, Biscayne Bay Environmental Center, 1277 NE 79th Street Causeway, Miami, Florida 33138

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Ross/CESAJ-DP-I
Scarborough/CESAJ-DP-C
Burns/CESAJ-PD

L: group/pdec/Jordan/Cooperating Agency Letters

Planning Division
Environmental Branch

SEP 1 1 2007

Mr. Mark Latch, Assistant Bureau Chief
Bureau of Natural and Cultural Resources
Florida Park Service
3900 Commonwealth Boulevard
Mail Station 530
Tallahassee, Florida 32399

Dear Mr. Latch:

In accordance with regulations pertaining to the National Environmental Policy Act (NEPA) Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. The purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study.

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We would appreciate a response to this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Ms. Terri Jordan, Biologist, at 904-232-1817 or Terri.L.Jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Acting Chief, Planning Division

Enclosure

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Scarborough/CESAJ-DP-C
Burns/CESAJ-PD

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Planning Division
Environmental Branch

SEP 1 1 2007

Ms. Mary Ann Poole, Director
Florida Fish and Wildlife Conservation Commission
Office of Policy and Stakeholder Coordination
620 South Meridian Street
Tallahassee, Florida 32399-1600

Dear Ms. Poole:

In accordance with regulations pertaining to the National Environmental Policy Act (NEPA) Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. The purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study.

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We would appreciate a response to this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Ms. Terri Jordan, Biologist, at 904-232-1817 or Terri.L.Jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Acting Chief, Planning Division

Enclosure

Copies Furnished:

Mr. Mark Robson, Director, Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries Management, 620 South Meridian Street, Tallahassee, Florida 32399-1600
Ms. Lisa Gregg, Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries Management, 620 South Meridian Street, Tallahassee, Florida 32399-1600

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Burns/CESAJ-PD

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Planning Division
Environmental Branch

SEP 1 1 2007

Mr. Eric Myers
Broward County ERP
Biological Resources Division
1 North University Drive
Suite 301
Plantation, Florida 33324-2038

Dear Mr. Myers:

In accordance with regulations pertaining to the National Environmental Policy Act (NEPA) Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. The purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study.

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We would appreciate a response to this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Ms. Terri Jordan, Biologist, at 904-232-1817 or Terri.L.Jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Acting Chief, Planning Division

Enclosure

Copy Furnished:

Mr. Ken Banks, Broward County ERP, Biological Resources Division, 1 North University Drive, Suite 301, Plantation, Florida 33324-2038

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Scarborough/CESAJ-DP-C
Burns/CESAJ-PD

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Planning Division
Environmental Branch

SEP 1 1 2007

Mr. Heinz Mueller
Environmental Protection Agency Region IV
Environmental Policy Section
61 Forsyth Street
Atlanta, Georgia 30303-3104

Dear Mr. Mueller:

In accordance with regulations pertaining to the National Environmental Policy Act (NEPA) Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. The purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study.

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We would appreciate a response to this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Ms. Terri Jordan, Biologist, at 904-232-1817 or Terri.L.Jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Acting Chief, Planning Division

Enclosure

Copies Furnished:

Mr. Richard Harvey, Environmental Protection Agency, 400 North Congress Avenue, Suite 120 West Palm Beach, Florida 33401
Mr. Ron Mediema, Environmental Protection Agency, 400 North Congress Avenue, Suite 120 West Palm Beach, Florida 33401

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Florida Fish and Wildlife Conservation Commission

Commissioners
Rodney Barreto
Chair
Miami
Kathy Barco
Jacksonville
Ronald M. Bergeron
Fort Lauderdale
Richard A. Corbett
Tampa
Dwight Stephenson
Delray Beach
Kenneth W. Wright
Winter Park
Brian S. Yablonski
Tallahassee

Executive Staff
Kenneth D. Haddad
Executive Director
Victor J. Heller
Assistant Executive Director
Karen Ventimiglia
Deputy Chief of Staff

Office of Policy and Stakeholder Coordination
Mary Ann Poole
Director
(850) 410-5272
(850) 922-5679
FAX

Managing fish and wildlife resources for their long-term well-being and the benefit of people.

620 South Meridian Street
Tallahassee, Florida
32399-1600
Voice: (850) 488-4676
Hearing/speech impaired:
(800) 955-8771 (T)
(800) 955-8770 (V)
MyFWC.com

October 10, 2007

Ms. Marie Burns
Acting Chief, Planning Division
U. S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, FL 32232-0019

Re: Florida Fish and Wildlife Conservation Commission, Cooperating Agency Participation

Dear Ms. Burns:

The Florida Fish and Wildlife Conservation Commission (FWC) graciously accepts your offer to become a cooperating agency for the Feasibility Study and integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Ft. Lauderdale, Florida.

It is our understanding that our participation as a cooperating agency would be limited to providing assistance to the U.S. Army Corps of Engineers (USACE) authors and contractors in developing language for the IEIS, reviewing and providing edits to draft language, and providing comments on those sections of the IEIS where the FWC has regulatory authority or specialized expertise.

It is important that the scope of our participation be limited to the above-stated activities due to limited staff resources. Should the USACE request any change in the scope of participation expected from the FWC, we would require 30 days advanced notice with the understanding that we may not be able to accommodate the request.

We appreciate the opportunity you are providing the FWC in becoming a cooperating agency, and look forward to working with your staff on the development of the IEIS for very important project. Please contact Lisa Gregg, our point person on this project, at 850-488-6058 or by email at lisa.gregg@MyFWC.com if you or your staff have any questions.

Sincerely,

Mary Ann Poole

Mary Ann Poole, Director
Office of Policy and Stakeholder Coordination

map/lg

Florida Department of Environmental Protection

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

November 5, 2007

Ms. Marie G. Burns
Acting Chief, Planning Division
U. S. Army Corps of Engineers
Jacksonville District
Post Office Box 4970
Jacksonville, Florida 32232-0019

Dear Ms. Burns:

Thank you for your letter of September 11, 2007, inviting the Florida Department of Environmental Protection (Department) to become a cooperating agency in the development of the Feasibility Study and Integrated Environmental Impact Statement (EIS) on the Port Everglades Harbor at Ft. Lauderdale, Florida. A copy of your letter is attached. I understand that the Department's Division of Recreation and Parks (Parks), Office of Coastal and Aquatic Managed Areas (CAMA), and other Department program areas also received invitations. I have discussed the matter with representatives of those offices and send you this unified Department response.

The Department accepts your invitation to become a cooperating agency and looks forward to working with your team on the Port Everglades Harbor Feasibility Study and Integrated EIS. To streamline communications between our agencies, the Office of Intergovernmental Programs will be the Department's point of contact during preparation of the Feasibility Study and Integrated EIS. Mr. Chris Stahl will be the direct contact. He can be reached at (850) 245-2169 or Chris.Stahl@dep.state.fl.us.

It is our understanding that as a cooperating agency, the Department will have the opportunity to review and comment on preliminary draft documents and will retain all final decision-making authorities to grant or deny future permits, water quality certifications, state lands easements, or sovereignty submerged lands authorizations, as well as to issue comments and consistency concurrences or objections through the Florida State Clearinghouse.

Ms. Marie G. Burns
November 5, 2007
Page 2 of 2

As a cooperating agency, the Department is prepared to devote to the scoping and draft EIS stages, the level of staff resources normally used to review and comment on a Draft EIS *after* its preparation, as required by 40 C.F.R. § 1501.6. To assist us in determining the personnel and budgetary allocations necessary to fulfill this commitment, however, we request that your team clearly outline its expectations for the Department in terms of specific tasks and schedules. The extent of our participation is naturally subject to budgeting and staff constraints.

If you have any questions or concerns, please contact Mr. Chris Stahl at (850) 245-2163, or by e-mail to Chris.Stahl@dep.state.fl.us. Otherwise, we will look forward to receiving from you the information requested on tasks and timeframes anticipated for the project.

Yours sincerely,

Sally B. Mann

Sally B. Mann, Director
Office of Intergovernmental Programs

cc: Michael W. Sole, Secretary, Department of Environmental Protection
Kelly Layman, Chief of Staff, Department of Environmental Protection
Colonel Paul L. Grosskruger, Jacksonville District Commander, U. S. Army Corps of Engineers, Jacksonville District
James E. Boone, State Liaison, U. S. Army Corps of Engineers, Jacksonville District
Janet Llewellyn, Director, Water Resource Management
Lynn Griffin, Coastal Program Administrator (OIP)
Chris Stahl, Environmental Specialist III (OIP)
Stephanie Bailenson, Director, Coastal and Aquatic Managed Areas
Mark Latch, Asst. Bureau Chief, Natural & Cultural Resources, Florida Park Service
Michael Barnett, Bureau Chief, Beaches and Coastal Systems

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

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November 15, 2007

Ms. Marie G. Burns
Acting Chief, Planning Division
U.S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

Subject: EPA Cooperating Agency Status; Feasibility Study and Integrated Environmental Impact Statement; Port Everglades Harbor; Broward County, Ft. Lauderdale, FL

Dear Ms. Burns:

The U.S. Environmental Protection Agency (EPA) has received your letter dated September 11, 2007, inviting this Agency to be a cooperating agency to the COE for its proposed Port Everglades Harbor Feasibility Study and EIS. We note from your letter that "[t]he purpose of the project is to evaluate potential project designs to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment to the maximum extent practicable while meeting the stated goals of the study."

Subject to resource limitations, EPA Region 4 accepts the offer to be a cooperating agency for the proposed Port Everglades Feasibility Study and EIS. EPA's cooperating agency status and level of involvement does not, however, preclude our independent review and comment responsibilities under the Section 102(2)(C) National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, or our authorities under Section 404 of the Clean Water Act. As a cooperator, we can offer early review and comment of COE EIS draft sections in areas of EPA mandates and expertise, as well as participation in selected meetings or teleconferences. EPA has already been involved with Port Everglades work through our South Florida Office.

EPA's NEPA contact for the NEPA review will be Chris Hoberg (404/562-9619 or hoberg.chris@epa.gov), while our South Florida Office contact regarding waters of the U.S. issues will be Ron Miedema (561/616-8741 or miedema.ron@epa.gov).

Sincerely,

Heinz J. Mueller, Chief
NEPA Program Office

BROWARD COUNTY FLORIDA

ENVIRONMENTAL PROTECTION DEPARTMENT – Biological Resources Division
Mailing Address: 115 South Andrews Avenue, Room A-240 • Fort Lauderdale, Florida 33301
954-519-1230 • FAX 954-519-1412

AD-EC
Jordan

October 8, 2007

Ms. Marie Burns
Acting Chief, Planning Division
Environmental Branch
Department of the Army
Jacksonville District, Corps of Engineers
PO Box 4970
Jacksonville, Florida 32232-0019

Dear Ms. Burns:

Thank you for your letter of September 11, 2007 inviting the Broward County Environmental Protection Department, Biological Resources Division to participate as a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) on the Port Everglades Harbor at Fort Lauderdale, Florida. We accept the invitation to serve as a cooperating agency with the clarification that our contributions will be limited to environmental issues. Also please be aware that, due to staffing constraints, our participation may be limited to reviews and comments on technical documents, teleconferences, and occasional travel. The point of contact for this assistance will be Kenneth Banks. He may be reached by telephone at (954) 519 1207, or by email at KBanks@broward.org. Again, we look forward to participating in this process and anticipate a successful outcome.

Sincerely,

Eric Myers

Eric Myers
Director

Cc: Phil Allen, Director, Port Everglades Department
Pam Madison, Director, Office of Public and Governmental Relations
Rick Wilkins, Director, Environmental Protection Department

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5511
(727) 824-5317; FAX (727) 824-5300
http://sero.nmfs.noaa.gov/

October 12, 2007 F/SER4:JK/pw

Marie G. Burns
Acting Chief, Planning Division
Jacksonville District
Department of the Army Corps of Engineers
PO Box 4970
Jacksonville, Florida 32232

Dear Ms. Burns:

NOAA's National Marine Fisheries Service accepts your invitation, dated September 11, 2007, to participate as a cooperating agency for the Feasibility Study and Integrated Environmental Impact Statement (IEIS) for Port Everglades Harbor. The purpose of the study is to evaluate alterative project designs to increase safety and efficiency of port operations while protecting essential fish habitat (EFH), coral, and other marine resources.

Due to competing priorities, our role as a cooperating agency will need to be limited to providing technical assistance on how impacts to threatened and endangered species and to EFH should be appropriately identified and mitigated. In this regard, we will be able to attend a reasonable number of meetings directed towards identifying and mapping areas likely to be impacted, assessing the affects of those impacts on NOAA trust resources, and examining options for mitigating those impacts. We also will be able to review and comment on drafts of the IEIS in advance of its release to the public and to develop limited amounts of text that describe NOAA's roles within the review process. Our service as a cooperating agency for the IEIS will be separate from our authorities and responsibilities under section 7 of the Endangered Species Act, Section 101(a)(5)(A) of the Marine Mammal Protection Act, and Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act.

We appreciate the opportunity to serve in this capacity for this important project. Related correspondence with our Protected Resources Division should be directed to the attention of Ms. Audra Livergood at our Miami office, 11420 North Kendall Drive, Suite 102, Miami, Florida 33176. Ms. Livergood may be reached by telephone at (305) 595-8352, or by e-mail at Audra.Livergood@noaa.gov. Related correspondence with our Habitat Conservation Division should be directed to the attention of Ms. Jocelyn Karazsia at our West Palm Beach office, which is co-located with the US Environmental Protection Agency at USEPA, 400 North Congress Avenue, Suite 120, West Palm Beach, Florida, 33401. She may be reached by telephone at (561) 616-8880, extension 207, or by e-mail at Jocelyn.Karazsia@noaa.gov.

Sincerely,

/ for

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

cc: (via electronic mail)

CESAJ, Terri.L.Jordan@usace.army.mil
EPA, WPB
FWS, Vero Beach
FWC, Tallahassee
FDEP OBCS, Tallahassee
FDEP, CAMA
SAFMC
Broward County, EPD
F/SER, Keys
F/SER3, Livergood, Hoffman
F/SER4
F/SER47, Karazsia

DP-C

PORT EVERGLADES

PORT EVERGLADES PILOTS, INC

Post Office Box 13017
Port Everglades, Florida 33316
Telephone (954) 522-4491/7
Fax (954) 522-4498

Florida's Deepest Harbor

March 22, 2007

U.S. Army Corps of Engineers
Jacksonville District
Attn: Richard Bonner
Deputy District Engineer
701 San Marco Blvd.
Jacksonville, FL 32207-8175

Dear Mr. Bonner:

In response to your continued request for our professional opinion on the various alternative channel designs, we would like to take this opportunity to expound on a previous letter sent to your office on August 15, 2006. These designs have been presented to us as alternatives to the straight design proposed years ago. While not professional channel designers, our job is to safely conduct the movement of vessels in and out of the port. We have experience in the movement of large vessels and consequently, we have consistently provided our input where appropriate to ensure that a viable channel design is achieved.

On at least five separate occasions over the last twelve years, we have participated in ship simulations of the channel at the Star Center. Through this process we have significantly whittled down the size and scope of the original proposed channel design. Our opinion emphatically remains that the straight channel design is the safest approach for the large deep draft containerships that intend to call at Port Everglades. We consider this channel design, specifically the 800 foot wide straight channel, to be the minimum size required for the targeted vessels and believe all of the Star Center simulations support this conclusion. A straight channel of this width would require sufficient depth to account for sea conditions and squat for a post-Panamax vessel transiting at a minimum of 12 knots. Anything other than a straight channel design would require significantly wider channels, wideners at the turns, and additional aids to navigation. Each of the alternative channel designs, using something other than a straight channel, would likely result in restrictions on vessel movements in periods of severe weather and extreme currents.

During the numerous simulations, actual transits with ACOE representatives, meetings, letters and conversations that we have participated in previously, we have continually pointed out the hazards of shifting currents and weather conditions that make the outer channel challenging as it presently exists. Those hazards increase dramatically with anything other than a straight channel. It should be noted that we currently have the option and ability to approach the existing channel obliquely, but elect not to since we feel it introduces an excessive amount of risk. Instead, we dramatically increase risk to our person by boarding large vessels in the rougher offshore seas a significant distance from the sea buoy. This affords us the opportunity to maneuver in deep open water and line up on the ranges well in advance to timely evaluate the set and drift.

When trying to turn a vessel within a narrow channel, the probability of going aground is exponentially increased with the amount of rotation required. Additionally, the hydrodynamic effects of a vessel nearing the limits of a channel are significantly magnified with greater draft due to the increase of both inertia and shallow water effect. "Restricted bottom clearance in shallow water impedes the flow of water underneath the ship, causing a restricted lateral motion of the aftship. The less bottom clearance, the more build-up of water on the side of the ship that the stern moves toward and the lower the water level on the side the ship moves away from, leading to a smaller drift angle and consequently a wider turn in shallow water."[1] In simpler terms, ships do not turn as well or as quickly when they are experiencing Shallow Water Effect, which begins when the depth of the water equals 1.5 times the draft of the vessel, with Full Shallow Water Effect achieved when the depth of the water equals 1.2 times the draft of the vessel.[2] When turning a large, deeply laden vessel in such a channel , "the depth under the keel will cause the turning diameter to increase until, in shallow water, it may be as much as twice the diameter found for the same ship in deep water." [3] Additionally, the impact of shallow water effects on the handling characteristics of the vessels is exacerbated by the open ocean exposure to wind and sea experienced at Port Everglades. Consequently, construction of a channel with turns, permanently introduces a dramatic increase in risk due to the diminished ability to precisely position the ship within the dredged channel.

None of the proposed alternatives provides sufficient maneuvering space required by the larger, deeper draft vessels for which the dredging is being proposed. In two of these alternatives, the radius of each turn is less than that of the deep water turning circle of the targeted vessel. As outlined in previous paragraphs, the dimensions of these turning circles can not be relied upon in shallow water. This puts the third alternative into significant question.

When a ship maneuvers in shallow water, more of the ship's power is absorbed by the water due to increased friction. The ship's speed decreases. "Larger waves and troughs are formed and the ship sinks closer to the bottom than she would do at the same speed over the ground in deep water. At the same time, the ship's trim changes, changing the directional stability of the vessel. The turbulence caused by the limited bottom clearance interferes with the rudder and propeller effectiveness and the turning circle increases."[4] Since these vessels will only be able to maneuver within the confines of the channel, failure to complete the turn will result in grounding with potentially significant environmental and economic impacts.

While these general statements can be accurately applied to all vessels, the ability to transit a particular channel is different for each ship. Factors such as stopping power, ship's maneuverability, directional stability, draft, trim, cargo load, ship's physical construction, maintenance condition, current, wind, sea, traffic, visibility, bottom clearance and bottom contour all play an important role in the ability of a ship to remain within the channel. The larger the vessel in relation to the channel size, the more each of these factors has an effect on the success of the transit.

As we have discussed, the outer channel of Port Everglades is exposed to very strong and unpredictable currents from the Gulfstream. These currents run both north and south in the approaches to the channel. It is not uncommon for a large vessel to be experiencing a current acting in one direction at the bow and in an opposing direction at the stern. Under this situation, a couple is applied to the vessel which may be contrary to the desired direction of a turn. The force on the hull of a vessel is multiplied by the square of the actual current velocity. The effect of this current increases dramatically when bottom clearance decreases.[5] The resulting force can quickly exceed the turning force of the rudder and the total combined bollard pull of all six tugs at Port Everglades. It should be noted that the ability of a tug to render assistance decreases dramatically as the ship's speed increases. The tugs at Port Everglades have a top speed of 12-14 knots. Therefore, if a ship is making 10-12 knots of headway, the tug is already using the majority of its available horsepower merely to motivate itself. This leaves little reserve horsepower left to apply to the ship.

An additional consideration is that anything other than the straight channel design will require substantial additions of aids to navigation. Each of the channel options will absolutely require additional range lights and markers for each leg (Alternative channel design #1 and #2 will require two sets of additional range lights), as well as additional buoyage. The range towers will either have to be constructed on the reefs themselves, or in some cases on prime property along Fort Lauderdale beach. They would have to be of sufficient size and intensity to be visible from a bridge height of at least 130 feet and be able to be distinguished from the oftentimes intense background lights. Further complications will arise from alternatives #2 and #3 that pass through the Navy restricted area south of the channel. There are significant scientific research projects and exercises involving national security conducted in this area.

At its inception, the channel design was targeting the Susan Maersk, although the targeted depth of the channel was never sufficient to bring in this vessel at its designed draft. In 1996, the Susan Maersk was under construction as the largest container vessel in the world. At that time, the dredge project could have been considered forward looking and progressive. Since then, significantly larger containerships have been built and even larger ones are in the design phase. The question we should be addressing today is not how we can minimize the construction impact in order to barely fit the Susan Maersk into Port Everglades, but rather how the project should be expanded to address the subsequent generations of vessels which currently operate on the east coast of the United States and would likely call at Port Everglades if there was sufficient room.

More than 30% of the world's container tonnage capacity is on vessels as large, or larger than the design vessel. In fact, 70% of new container ship construction is of vessels larger than the design vessel. **The Panama Canal will begin expanding to handle vessels of 12000 TEU's by the end of 2009. This is nearly double the size of the Susan Maersk. The originally accepted 800' wide straight channel design is already undersized for what are the largest containerships of today. The channel may be inadequate for vessels which will be common in the near future. Even to a casual observer, it should be apparent that** worldwide container traffic is increasing and will continue to increase. There is simply insufficient land mass available at a single South Florida port to accommodate the anticipated future container traffic, thus necessitating several options for ships to call upon ports in Florida.

The Port Everglades Pilots have already rejected requests by companies wishing to immediately begin container services with post Panamax vessels in Port Everglades. These companies already operate services in our port and are currently operating post Panamax vessels of this size into Freeport, Bahamas and Savannah, Georgia. The new large vessel services were rejected pending completion of the dredge project. The entire Master planning process of Port Everglades depends on the completion of this dredging which seems to be at a standstill. It is increasingly likely that the Susan Maersk will be scrapped before any of the dredging begins.

When considering the current world fleet, and the economic projections for South Florida ports, we question the wisdom of the process which seeks to limit channel size and alter the configuration of the channel as these alternatives propose. We believe the straight channel design offers the best alternative and represents the safest approach for the large deep draft containerships that intend to call at Port Everglades.

Sincerely,

Port Everglades Pilots Association

Michael J. Cunningham

Cc: Allan Sosnow – Environmental Project Manager, Port Everglades

[1] Behavior and Handling of Ships by Henry H. Hooyer, pg 35

[2] Shiphandling for the Mariner, Third Edition, by Daniel H. MacElrevey, pg 8

[3] Shiphandling for the Mariner, Third Edition, by Daniel H. MacElrevey

[4] Port Revel Shiphandling Manuel, 1999, Jean Graff, p.65

[5] Port Revel Shiphandling Manuel, 1999, Jean Graff, p.64

PORT EVERGLADES

Florida's Deepest Harbor

PORT EVERGLADES PILOTS' ASSOCIATION
Post Office Box 13017
PORT EVERGLADES, FLORIDA 33316
Telephone (954) 522-4491 / 7
Facsimile (954) 522-4498
E-mail: pilots@bellsouth.net

August 15, 2006

Ms. Terri Jordan
Biologist, Environmental Branch – Planning Division
Jacksonville District – SAD
US Army Corps of Engineers
701 San Marco Blvd.
Jacksonville, FL 32207

Dear Ms. Jordan:

The Port Everglades Pilots' Association has reviewed the alternative channel designs as depicted in OEC-Alt1.jpg, OEC-Alt2.jpg, OEC-Alt3.jpg that were emailed to us on July 26th of this year. I would like to remind you that we have already addressed these alternative plans and others during the original simulation phase and rejected them.

Our concerns are for the high level variations in current magnitude (many times in the 3-5 knot range) and direction which are frequently encountered in the areas surrounding the sea buoy, "PE", and the entire Outer Bar Cut. Some of the vessels that presently call at Port Everglades are frequently challenged by these cross-currents which often REVERSE direction at least once, if not TWO or THREE more times during the transit from the entrance to the jetties. The introduction of additional obstacles for even larger, heavier, less maneuverable vessels is not prudent. Any design other than a straight channel will be imposing a permanent risk of groundings that will forever increase as vessels get larger.

Since our only recommendation is a straight channel approach, it is not necessary to address (in any detail) the necessity of additional permanent, fixed structure aids to navigation that would themselves have significant environmental, economic and aesthetic impact, as well as presenting an additional allision danger.

We are charged by the State of Florida and the Federal Government to provide the safest possible transit of vessels in and out of Port Everglades. Undoubtedly, the straight channel approach that is in the current design study is the safest and therefore the most environmentally sound choice. It is the only option that we can endorse.

Thank you for your consideration in this matter.

Sincerely,

Port Everglades Pilots' Association

Captain Thomas G. Hackett
Co-Managing Pilot

Captain Bruce Cumings
Co-Managing Pilot

TGH:ljb

C:\Personal\Managing Pilot Info.ACOE Alternative Channels.ltr

Jeb Bush
Governor

Department of Environmental Protection

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

David B.
Secret

September 26, 2001

Colonel James G. May
U.S. Army Corps of Engineers
Post Office Box 4970
400 West Bay Street
Jacksonville, Florida 32232-0019

Dear Colonel May:

Since February 2000, staff from the Department's Division of Recreation and Parks has been working closely with the Corps' project manager on the development of the Port Everglades Feasibility Study to expand the port. We have been extremely pleased with the communication and cooperation that has been extended to the department throughout the course of the study. While the initial proposal for the expansion anticipated as much as 54 acres of impact to John U. Lloyd Beach State Park, the proposals presented at the Alternative Feasibility Briefing on August 28 anticipated only one to three acres of loss to the park, depending on the design.

Although we appreciate the efforts to date to reduce the anticipated impacts to the park, I ask that further effort be made to eliminate or minimize the impacts.

If any of the alternatives that are chosen require taking of state land, approval from the Board of Trustees will be required. As part of the process to evaluate the taking of state land, the Board of Trustees will utilize their "Incompatible Use" policy (copy enclosed) in evaluating the request.

We look forward to continuing the cooperative efforts concerning this project.

Sincerely,

David B. Struhs
Secretary

DBS/mls

Enclosure

cc: Mr. Bob Ballard, Deputy Secretary
Ms. Eva Armstrong, Director, Division of State Lands
Mrs. Wendy Spencer, Director, Division of Recreation and Parks
Mr. Benji Brumberg, Ombudsman

POLICY

INCOMPATIBLE USE OF NATURAL RESOURCE LANDS

APPROVED BY

BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND

ON AUGUST 9, 1988

(1) The Trustees may authorize the use of natural resource lands if it determines that:

(a) The use is in the public interest. The public interest determination will be based on a careful weighing of the likely adverse impacts of the use on natural resource lands against the public benefits of the proposed use. Factors to be assessed in the public interest determination include but are not limited to conservation, environmental concerns, wetlands, fish and wildlife, historic and archaeological resources, economics and aesthetics, land use, water quality and quantity, navigation, public safety, and degree of public use and enjoyment of the natural resources lands;

(b) The use is not incompatible with the major or primary purpose for which the lands are held or were acquired, and will not have an unacceptable adverse effect, either individually or in combination with other known uses, on the natural resource lands nor substantially interfere with public recreational use and enjoyment of such natural resource lands;

(c) There is no practicable alternative to the proposed use that would have less adverse impact on such lands or public use of them; and

(d) If the use is to be located on state forests, parks, EEL, CARL, LATF or other state natural resource lands, it will provide a net positive benefit to the particular lands on which the use will be located and if the use is to be located on EEL lands, it must be in strict accord with the public purpose for which the land was acquired.

The management plan for the lands and the conceptual state lands management plan shall be considered in the above determinations.

(2) If the trustees decide to authorize the use of natural resource lands, it may impose conditions to mitigate or minimize the adverse impact of the use on the natural resources and the public use and enjoyment of the lands. Those impacts may be minimized through:

(a) Proper location of the use, and by limiting the size of the areas authorized for such use;

(b) By selecting a site that has already been impacted, is less sensitive than other sites, or experiences less public use;

(c) Placing restrictions on construction and operation activities and practices that are designed to reduce adverse impacts;

(d) Designing access roads and site preparation to avoid interference with water circulation and fluctuation and impacts on other natural resources and public use and enjoyment;

(e) Avoiding sites with unique wildlife habitats, natural aquatic areas, wetlands, or other valuable natural resources, and locating the use at the periphery of the land;

(f) Selecting sites to prevent or minimize damage to scenic vistas and other aesthetically pleasing features;

(g) Selecting sites that will not increase incompatible human activity;

(h) Imposition of best management practices;

(i) Requiring the acquisition of mitigation lands adjacent to or within the boundaries of the affected natural resource lands.

(3) For the purpose of this policy:

(a) "Beach" means the zone of unconsolidated material that extends landward from the mean low water line to the place where there is marked change in material or hysiographic form, or to the line of permanent vegetation (usually the effective limit of storm waves). Unless other wise specified, the seaward limit of a beach is the mean low water line.

(b) "Natural resource lands" includes those lands acquired with funds from the CARL Trust Fund LATF or EEL program and lands managed as state parks, state recreation areas, state archaeological sites, state historic sites, state preserves, state sanctuaries, state wilderness areas, state forests, state owned wildlife management areas, and state owned beaches.

(c) "Incompatible use" means any use of natural resource lands that would jeopardize the integrity of the natural resource, or diminish the primary utility of such lands relative to the purposes for which they were acquired. Incompatible use does not include minor and temporary activities such as volleyball, sail gliding, art events, running events, music events, holiday activities or other customary recreational activities and associated support facilities; provided that these activities do not involve the placement of any major structures that will remain in place for more than 72 hours and will not substantially or unreasonably interfere with public access to and use of natural resource lands.

(d) "Natural resources" means wetlands, lakes, rivers, streams and other waterbodies, flora, fauna, fish and wildlife habitat, historical and archaeological resources, scenic vistas, and aesthetic values.

(e) "Net positive benefit" means any effective action or transaction which promotes the overall characteristics of a particular parcel of natural resource lands. It is compensation over and above the market values of affected parcel to offset any requested use or activity which would preclude or affect, in whole or in part, current of future uses of the natural resource lands. Net positive benefit shall not be solely monetary compensation, but shall include mitigation and other consideration related to environmental or management development or restoration that produces a new or modified environment that is more productive or is ecologically more valuable.

(f) "Practicable alternatives" means the use of an alternative location if such location is capable of accommodating the proposed use and could be reasonably obtained in a timely manner.

(g) "Substantially interfere with" means the use would significantly diminish the public use and enjoyment of the natural resource lands.

(h) "Trustees" means Board of Trustees of the Internal Improvement Trust Fund.

(i) "Unacceptable adverse affect" means impact on natural resources that is likely to result in significant degradation, impairment or loss of these resources.

(j) "Use means the customary and acceptable use of natural resource lands for purposes other than the conservation of natural resources or public recreational use and enjoyment of the lands.

SEP 08 2001

Planning Division
Environmental Branch

Mr. Jay Slack
Field Supervisor
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, Florida 32960

Dear Mr. Slack:

Pursuant to the Endangered Species Act, as amended, the U.S. Army Corps of Engineers, Jacksonville District, is requesting a list of threatened or endangered species and critical habitat for species under the jurisdiction of the Fish and Wildlife Service in the vicinity of Port Everglades, Broward County, Florida (See enclosed map).

The point of contact for this project is Mr. Rea N. Boothby at 904-232-3453.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Boothby/CESAJ-PD-EA/3453/slw 9/4/01
Adams/CESAJ-PD-EA
Dugger/CESAJ-PD-E
Schmidt/CESAJ-PD-PN
~~Fore/CESAJ-DP-I~~
Strain/CESAJ-PD-P
Duck/CESAJ-PD

Port Ev. FWS Sect 7 2001

SEP 0 5 2001

Planning Division
Environmental Branch

Mr. Charles A. Oravtez
Chief, Protected Species Management Branch
National Marine Fisheries Service
9721 Executive Center Drive North
St. Petersburg, Florida 33702

Dear Mr. Oravetz:

Pursuant to the Endangered Species Act, as amended, the U.S. Army Corps of Engineers, Jacksonville District, is requesting a list of threatened or endangered species and critical habitat for species under the jurisdiction of the National Marine Fisheries Service in the vicinity of Port Everglades, Broward County, Florida (See enclosed map).

The point of contact for this project is Mr. Rea N. Boothby at 904-232-3453.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Boothby/CESAJ-PD-EA/3453/slw 9/4/01
McAdams/CESAJ-PD-EA
Dugger/CESAJ-PD-E
Schmidt/CESAJ-PD-PN
~~Fore/CESAJ-DP-I~~
Strain/CESAJ-PD-P
Duck/CESAJ-PD

W/boothby/Port Ev.NMFS Sect 7

FLORIDA
TRANSPORTATION
SERVICES, INC.

Post Office Box 22696 • Fort Lauderdale, FL 33335-2696

May 16, 2001

Mr. Bradd Schwichtenberg
U.S. Army Corps of Engineers
Jacksonville District
Planning Division
P.O. Box 4970
Jacksonville, FL 32232

RE: Port Everglades

Dear Mr. Schwichtenberg:

We are writing in support of the Feasibility Study on the possible expansion of Port Everglades's waterways. As long time stevedores, terminal operators and steamship agents in Port Everglades, we have witnessed first hand the increasing congestion in berthing due to the increased size and number of vessels calling the port.

We are especially interested in any improvements proposed to the Dania Cutoff Canal, as such improvements may lead to the development of additional berthing there.

It is vital to South Florida that Port Everglades stay competitive. To do so, its infrastructure must be improved. This cannot be accomplished without the simultaneous improvement of its waterways.

Sincerely,

Florida Transportation Services, Inc.

John C. Gorman, Jr.
President

cc: Mr. Allan D. Sosnow, Port Everglades

GRADY MARINE CONSTRUCTION, INC.
General Marine Contractors "We Barge Right In"

May 11, 2001

Mr. Bradd Schwichtenberg
U.S. Army Corps of Engineers
Jacksonville District
Planning Division
P.O. Box 4970
Jacksonville, FL 32232

Dear Mr. Schwichtenberg:

We are Port Everglades users and long time tenants. We support any efforts on your part to conduct a Feasibility Study of the Port's waterways.

It is apparent that to maintain our Port leadership role on the East Coast, we must continue to improve our facilities to accommodate larger, deep draft vessels.

Please feel free to call on us for additional information or assistance from the local level.

Respectfully,

John J. Grady Jr.

CONTINENTAL

Port Everglades Terminal: Slip 3 Eisenhower Boulev
Port Everglades, Florida
Phone: (954) 523-8442
Fax: (954) 523-0156

Mailing Address: P.O. Box 13128
Port Everglades, Florida

May 11, 2001

Mr. Bradd Schwichtenberg
U.S. Army Corps of Engineers
Jacksonville District
Planning Division
P.O. Box 4970
Jacksonville, FL 32232

Dear Mr. Schwichtenberg,

Our Company, Continental Florida Materials Inc./Lehigh Portland Cement is in favor of the proposed expansion project at the Port of Jacksonville.

Deeping and widening the Port will make it possible for us to use bigger and wider ships.

Regards,

Lars Alm
VP Operations

6500 North Andrews Avenue, Suite 200
Fort Lauderdale, Florida 33309
Phone: (954) 351-1800

2100 South Ocean Lane, Apt. 706 • Fort Lauderdale, Florida 33316 • (954) 463-3875 • Fax (954) 463-9509

May 8, 2001

Mr. Bradd Schwichtenberg, Planning Division
U.S. Army Corps of Engineers, Jacksonville District
P.O. Box 4970
Jacksonville, FL 32232

Dear Mr. Schwichtenberg:

I write in support of the proposed dredging project at Port Everglades, Florida.

I am a former Port Everglades Commissioner and Chairman and have been closely associated with various businesses at the port, including Tracor Marine Inc., of which I was president, and Hvide Marine Incorporated (now Seabulk International), of which I was recently chairman, president, and chief executive officer. I am a co-founder of the Port Everglades Association, the business group at the port.

In my 25 years of close association with Port Everglades I have watched with pleasure the port's growth and development. What not long ago was a quiet, sleepy seaport whose business was more than ninety per cent dependent on petroleum imports is now a bustling, vigorous, highly diversified seaport whose major businesses include petroleum, container, and cruise. Today, Port Everglades is rightly described as *the* engine of Broward County's commerce and industry, employing directly or indirectly thousands of men and women and bring millions of dollars into the local economy annually.

But the port's progress is jeopardized by the continuing increase in the sizes of container and cruise ships and the realities of navigation in the existing harbor. Deeper water in the entrance channel, the turning basin, and elsewhere at Port Everglades is absolutely necessary if the port is to continue to provide modern services to the world maritime industry.

Accordingly, I strongly urge your support of the planned dredging project at Port Everglades, with the hope that the project can be moved expeditiously through the approval and appropriations processes and promptly get underway. The planned dredging is vital if the port's full potential is to be realized.

Sincerely,

Jean Fitzgerald

SOUTH STEVEDORING, INC.
2550 EISENHOWER BLVD., BLDG. 611, OFFICE 211/212
FORT LAUDERDALE, FL 33316
TELEPHONE: (954) 525-4204
FAX: (954) 522-6463

SOUTH FLORIDA TERMINAL SERVICES
3800 MCINTOSH ROAD
FORT LAUDERDALE, FL 33316
TELEPHONE: (954) 768-0660
FAX: (954) 524-3859

May 7, 2001

Mr. Bradd Schwichtenberg
U.S. Army Corps of Engineers
Jacksonville District
Planning Division
P.O. 4970
Jacksonville, Florida 32232

Dear Mr. Schwichtenberg,

As a long time tenant of Port Everglades, my company South Stevedoring, Inc. and I are very much in favor of the Feasibility Study for the global Expansion of the Port Everglades Harbor. We are much aware of the potential to bring post-panamax vessels to the Port and this event can only be accomplished with deep water and a channel wide enough to accommodate the safe passage of vessels through the Southport Access Channel.

As a new terminal facility at Port Everglades, we are also looking forward to the improvements scheduled for the Turning Notch and the proposed improvements to the Dania Cutoff Canal.

If there is any way my company or I can assist you or the Port in the speedy development of the Port's new facilities, please do not hesitate to call on me.

Sincerely,

Arthur Scott

Arthur Scott
President Terminal Operations

cc: Stephen C. Harrington

TECMARINE LINES, INC.

5/4/01

Mr Bradd Schwichtenberg
U.S. Army Corps of Engineers
Jacksonville District
Planning Division
PO Box 4970
Jacksonville, Florida 32232

Subj: Port Everglades Expansion Plans, Feasibility Study

Dear Mr Schwichtenberg:

Tecmarine is a moderate sized liner operation operating and based in Port Everglades. We have been proponents and clients of the port since 1989. During that time we have seen the progress and growth of this port.

We feel that the result of the Feasibility Study must show that the widening and deepening of the port is not only a good plan but frankly essential to the health of the port in the future and directly impacting us, one of the port users. Any benefit that allows healthy economic growth and therefore the growth of the port user community is vital.

We support the dredging of the Southport Access Channel, Turning Notch and Dania Cutoff Canal. This step is only a first step in the long range needs and plans for the port and it simply must happen if we are to be successful in Port Everglades and I refer the "we" as a member of the por community.

I hope you can support our position and we do indeed see this dredging come about in timely order.

Thank you for taking the time to review our position.

Robert "Bob" Callahan
Senior Vice President
Marine Operations

Building 205 S.E. Street • Port Everglades, Florida
Telephone. (954) 331-2000 or (305) 597-7000 • Fax: (954) 331-1950 or (305) 594-4446

STATE OF FLORIDA
DEPARTMENT OF COMMUNITY AFFAIRS
"Dedicated to making Florida a better place to call home"

JEB BUSH
Governor

STEVEN M. SEIBERT
Secretary

April 27, 2001

Mr. James C. Duck
Department of the Army
Jacksonville District Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232-0019

RE: Department of the Army - District Corps of Engineers - Notice of Intent to Prepare Draft Environmental Impact State (DEIS) - Port Everglades Harbor - Feasibility Study of Navigation Improvements - Broward County, Florida
SAI: FL 200103150126C

Dear Mr. Duck:

The Florida State Clearinghouse, pursuant to Executive Order 12372, Gubernatorial Executive Order 95-359, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 14 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated the review of the above-referenced project.

The Department of Environmental Protection (DEP) offers an number of comments and concerns relating to the project's waste cleanup and petroleum storage methods and their environmental impacts to the Port Everglades vicinity. Please refer to the enclosed DEP comments for more detail.

The Florida Fish and Wildlife Conservation Commission (FWC) offers a list of concerns regarding the project's environmental impacts. These include how increased lighting and dredged materials placement will affect nesting turtles, how the project will impact seagrasses and other nearshore and hard bottom habitat, how reducing navigational width of the Dania Cutoff Canal will impact manatees and recreational boaters, and how the project's dredging methods (including blasting) will impact manatees and other marine mammals. Please refer to the enclosed FWC comments for more information.

2555 SHUMARD OAK BOULEVARD • TALLAHASSEE, FLORIDA 32399-2100

Mr. James C. Duck
April 27, 2001
Page Two

Finally, the South Florida Regional Planning Council (SFRPC) has identified goals and policies in its Strategic Policy Plan which may apply to the project. We have enclosed the SFRPC's comments for your review and consideration.

Based on the information contained in the notice of intent and the enclosed comments provided by our reviewing agencies, we have determined that the referenced project is, at this stage, consistent with the Florida Coastal Management Program (FCMP). All subsequent environmental documents prepared for this project must be reviewed to determine the project's continued consistency with the FCMP. The state's continued concurrence with this project will be based, in part, on the adequate resolution of any issues identified during this and subsequent reviews.

Thank you for the opportunity to review this project. If you have any questions regarding this letter, please contact Ms. Jasmin Raffington at (850) 414-6568.

Sincerely,

Joseph F. Myers, Acting Executive Director
Florida Coastal Management Program

JFM/hv

Enclosures

cc: Robert Hall, Department of Environmental Protection
Brian Barnett, Fish and Wildlife Conservation Commission
Eric Silva, South Florida Regional Planning Council
Jim Golden, South Florida Water Management District

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administratio
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, Florida 33702

April 26, 2001

James C. Duck, Chief
Planning Division, Environmental Branch
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Duck:

The National Marine Fisheries Service (NMFS) attended the March 29, 2001, Scoping Meeting for the development of an Environmental Impact Statement (EIS) for the Port Everglades Harbor Navigation Channel Improvements project. The proposed project is located in the vicinity of Dania Sound, Broward County, Florida. The draft EIS being prepared for this project is expected to be available in September 2001. At the request of the Army Corps of Engineers (COE), Planning Division, the NMFS provides the following preliminary comments for your consideration.

According to information provided during the referenced meeting, several navigational improvements to the Port are being investigated. These include: widening and deepening the Outer and Inner Entrance Channel, the Southport Access Channel, Turning Notch, and Dania Cutoff Canal; deepening the Main Turning Basin and adjacent turning basins; constructing bulkheads along the Southport Access Channel; moving the existing Coast Guard facilities east to accommodate the new channel configurations; and, creating a new turning basin at the south end of the Southport Access Channel. Some of the stated objectives of the project include providing access to the Port for larger vessels such as post-Panamax cargo and Eagle Class cruise ships. Several spoil disposal options are being considered including beach disposal at John U. Lloyd Park and on-site, upland disposal. Mitigation options for impacts to estuarine and marine resources are being developed, but are expected to include wetland creation/restoration at West Lake Park in Broward County.

Based on the description of the activities under consideration, the NMFS is concerned that the proposed project may have significant adverse impacts to Essential Fish Habitat (EFH) as defined by 1996 amendment to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). Based upon information provided at the EIS Scoping Meeting, potential impacts to EFH and NMFS-trust resources include:

- Approximately 5 acres of dredging within areas supporting seagrasses (including approximately 1 acre of Johnson's seagrass);
- Approximately 23 acres of dredging and/or filling activities within mangrove wetlands;
- Approximately 63 acres of dredging impacts to hard bottom habitat (based upon mapping used in the Coast of Florida Study in 1996. New video surveys scheduled for May 2001

are expected to indicate a lesser amount of hard bottom in this area); and,
- Approximately 0.7 acre of dredging impacts to coral reef habitat.

Seagrasses, estuarine scrub/shrub mangroves, live/hard bottoms, coral and coral reefs, estuarine mud bottom, and the estuarine and marine water column have been identified as EFH by the South Atlantic Fishery Management Council (SAFMC). In addition, submerged aquatic vegetation, hermatypic coral reefs, hard bottoms, and mangroves have been designated as Habitat Areas of Particular Concern (HAPC) by the SAFMC. HAPCs are subsets of EFH that are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area.

Rock blasting may be proposed in the area of the Outer Entrance Channel, within the Main Turning Basin, and possibly along the Dania Cutoff Canal. We are concerned that blasting within these areas may have additional adverse impacts to fish and sea turtles that utilize these areas for foraging and shelter. In particular, blasting within the Outer Entrance Channel may effect organisms associated with hard bottom and coral habitats adjacent to the channel.

It is our understanding that several areas within the Southport Channel contain environmental conservation easements that would be impacted by several of the proposed alternatives. We are concerned with the loss of areas designated as environmental conservation easements.

Preliminary information has indicated that mitigation for impacts to marine and estuarine habitats could be provided by wetland creation and restoration at West Lake Park in Broward County. According to information provided at the EIS Scoping Meeting, there are approximately 55 acres of land at the Park that may be available as mitigation areas. The NMFS has also reviewed an EIS for the Fort Lauderdale-Hollywood Airport Expansion, which is expected to impact approximately 38.2 acres of fresh water emergent and mangrove wetlands. The proposed mitigation area for the airport expansion project is also the West Lake Park, and we have some concern that sufficient area may not be available at this site to accommodate mitigation for these two projects.

Considering the potential impact from the proposed project on EFH, HAPC, and other NMFS-trust resources, we recommend that the following should be addressed in the draft EIS:

1. An EFH Assessment should be completed that identifies and describes EFH resources in the vicinity of the project, assess the impacts to EFH associated with each action alternative, the COE's views regarding the effects of the action on EFH, and the proposed mitigation to fully offset any losses of EFH;

2. Alternatives to blasting should be fully analyzed and considered to reduce adverse impacts to NMFS trust resources, including EFH and HAPC, within the project vicinity;

3. Potential impacts to environmental conservation easements should be fully analyzed including the need to affect these areas, practicable alternatives to affecting these areas, and the type and amount of mitigation that is would be necessary to fully compensate for the loss of these areas; and,

4. A comprehensive mitigation plan should be included with a complete analysis of the

proposed locations, and availability, for wetland restoration and/or creation for this project. In-kind mitigation should be provided for all habitat types impacted from the proposed project and long-term monitoring should be included to ensure that complete recovery and compensation is ultimately provided.

We look forward to the opportunity to provide additional comments to the draft EIS upon its availability. If we can be of further assistance, please advise. Related comments, questions or correspondence should be directed to Mr. Michael R. Johnson, in Miami, at 305/595-8352.

Sincerely,

For Andreas Mager, Jr.
Assistant Regional Administrator
Habitat Conservation Division

cc:
EPA, WPB
DEP, WPB
FFWCC, Tallahassee
FWS, Vero Beach
F/SER3
F/SER4
F/SER43-Johnson

Coastal
The Energy People

April 26, 2001

Mr. Brad Schwichtenberg
U. S. Army Corps of Engineers
Jacksonville District
Planning Division
P. O. Box 4970
Jacksonville, FL 32232

Subject: Port Everglades Expansion and Environmental Impact Study

Dear Sir:

The El Paso Corporation fully supports the global expansion of the Port Everglades waterway. The Port has witnessed dramatic growth in all business sectors throughout its history by continually looking to the future and finding ways to better serve the needs of its customers. The Petroleum, Cruise and Cargo industries are the three main revenue sources for the Port and all three will begin utilizing larger vessels in the near future to remain competitive.

For these larger vessels to bring their goods and services to Port Everglades, the Port must explore widening and deepening the Outer and Inner Entrance Channels, the three turning basins, the Southport Access Channel, the Turning Notch and improvements to the Dania Cutoff Canal. However, due to the vast environmentally sensitive areas within the confines of the Port, we believe a thorough environmental assessment needs to be completed before any dredging is initiated. To this end, we support the Draft Environmental Impact Study proposed by the Army Corps of Engineers (COE), Jacksonville District.

I would appreciate a copy of the study when completed. My forwarding address is:

Terminal Manager
El Paso Corporation
P. O. Box 13124
Port Everglades, FL 33316

Please call me at (954) 355-4245 if you have any questions or need additional information.

Sincerely,

Karl Bernard
Terminal Manager

CROWLEY
LINER SERVICES
A Subsidiary of Crowley Maritime Corporation

April 24, 2001

Mr. Brad Schwichtenberg
U. S. Army Corps of Engineers
Jacksonville District Planning Division
P. O. Box 4970
Jacksonville, FL 32232

Dear Mr. Schwichtenberg:

Crowley Liner Services is a major user of the Port Everglades facilities. We average in excess of 430 ship calls per year serving our customers in the Virgin Islands, Windward and Leeward Islands, Dominican Republic, Bahamas, Jamaica, Guatemala, Honduras, Costa Rica, Panama and Mexico.

Improvement of the port facilities, including dredging and widening the channels and turning basins is of considerable importance to our company. Projects such as improvements to the Dania Cutoff Canal are strongly supported to provide additional dockage. Berthing congestion is an ongoing problem for the Port Everglades Harbormaster.

Crowley Liner Services strongly supports expansion of Port Everglades and improvement of existing facilities to better support current requirements and provide the opportunity to enhance the utility of the port and economic growth.

Very truly yours,

Thomas Morin

Thomas Morin
Manager, Vessel Operations

TM/ao

SEABULK INTERNATIONAL

Seabulk International, Inc. • 2200 Eller Drive • P.O. Box 13038 • Fort Lauderdale, FL 33316
www.seabulkinternational.com

Alan R. Twaits
Senior Vice President
and General Counsel

Phone: (954) 524-4200 Ext. 801
Fax: (954) 527-1772
E-mail: alan.twaits@sbulk.com

April 23, 2001

Mr. Bradd Schwichtenberg
U.S. Army Corps of Engineers
Jacksonville District/Planning Division
PO Box 4970
Jacksonville, FL 32232

RE: Port Everglades

Dear Mr. Schwichtenberg:

It has come to our attention that the U.S. Army Corps of Engineers is conducting a Feasibility Study on widening and deepening entrance channels, turning basins, access channels, the turning notch and the cutoff canal at Port Everglades. Seabulk International, Inc. ("Seabulk") (f/k/a Hvide Marine Incorporated) strongly supports the Port Everglades project, which would allow needed expansion and improvement to ship operations at the port. As holder of the tug franchise at Port Everglades, Seabulk operates a fleet of five state-of-the-art tug vessels at Port Everglades. Seabulk and its tug captains know the characteristics of the port as well as any other group. We work hand in hand with the pilots and vessel operators to guide and berth tankers, container ships, bulk carriers, roll on roll off ships, special purpose ships and cruise ships. Seabulk also operates a fleet of ten of its own U.S. flag petroleum and product tankers, five of which are state of the art double hulls. Some of our tanker fleet are regular visitors to Port Everglades, so we are also intimately aware of the tight confines of the port and its channels and berths as vessel owners and operators.

Port Everglades is a unique port, with narrow confines, bends and turns, and narrow channels and berths. Nowhere else is the mix of cruise vessels, cargo vessels, recreational yachts, small boats, the intercoastal waterway, and pristine beaches and natural areas in such close proximity. They conspire to create uniquely compelling reasons for widening and deepening at Port Everglades.

(1) Vessels are continuing to get larger. Cruise ships and container ships at Port Everglades have already grown with cruise ships over 110,000 dwt and 3,000 passengers, and 1,000 foot container ships with over 4,500 TEU capacity. And larger ones are on the way.

If the port is going to stay competitive and continue to be a safe place to operate the big ships, the port and the Army Corps need to anticipate and plan for the future to be able to handle them. The current tightness and minimal tolerances in the port would be alleviated by the project, providing easier and safer access. The presence of large amounts of yacht and pleasure boat traffic at the port accentuates the need.

(2) Widening and deepening will enhance and expedite safe arrivals, departures and shifting of port traffic. For example, this will reduce the number of loaded tankers waiting at the sea buoy to enter the port, consequently reducing traffic and the possibility of incidents there.

(3) An accident in the current narrow channels and berths could impede ship traffic flow. Widening and deepening will reduce the threat of accidents and resulting bottlenecks.

(4) Dredging projects are inherently slow and time-consuming. We need to begin this project as soon as possible.

(5) Port Everglades is the largest petroleum storage port south of New York City, the world's second or third largest cruise port, and a major container gateway to the Caribbean and Central and South America. It has grown fast and, with the right infrastructure mix, can continue to grow to meet the import and export needs of the economy of the southeast U.S., including, on the import side, vital energy needs. To continue to meet these needs, as well as to remain competitive with new, special purpose terminals in the Bahamas and elsewhere, Port Everglades needs the widening and deepening project.

Seabulk appreciates the opportunity to make its views heard. Our experts at the port, where we also have our corporate headquarters, stand ready to assist with any questions or issues which you would like us to address. Please contact the undersigned should you require additional input from Seabulk.

Sincerely,

Alan R. Twaits

Cc: Paul DeMariano, Port Director, Port Everglades
Gerhard E. Kurz, President and CEO, Seabulk International, Inc.
William R Ludt, President, Towing Division, Seabulk International, Inc.
Bob Turpin, Director, Seabulk Towing Operations, Port Everglades

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSIO

OFFICE OF ENVIRONMENTA
BRADLEY J. HARTMAN,
(850)488-6661 TDD (
FAX (

April 19, 2001

Ms. Jasmine Raffington
Florida State Clearinghouse
2555 Shumard Oak Blvd.
Tallahassee, Florida 32399-2100

Re: SAI #FL200103150126C,
USACOE Notice of Intent to Prepare Draft
Environmental Impact Statement-Port Everglades
Harbor-Feasibility Study of Navigation
Improvements, Ft. Lauderdale, Broward County

Dear Ms. Raffington:

The Office of Environmental Services of the Florida Fish and Wildlife Conservation Commission (FWC) has reviewed the referenced project, and offers the following comments.

This project involves the development of a Draft Environmental Impact Statement (DEIS) for the Port Everglades Harbor, Feasibility Study of Navigation Improvements. These improvements involve proposed deepening and widening of channels and turning basins at the port. FWC staff has attended several meetings, organized by the Army Corps of Engineers, of all interested agencies regarding the feasibility of the port improvements. We continue to have the same concerns about issues potentially associated with this project that we have expressed at those meetings, and expect they will be addressed in the DEIS. They are as follows:

1. Increased lighting from the port impacting sea turtle nesting at John U. Lloyd State Park.
2. Placement of any dredged material on the beach.
3. Impacts to seagrasses that serve as manatee and sea turtle foraging habitat.
4. Impacts to nearshore hard bottom habitats utilized as developmental habitat by juvenile green turtles.
5. The potential reduction in the available navigational width in the Dania Cutoff Canal due to increased vessel mooring, thus reducing the amount of waterway available for manatees and boaters to use.
6. Proposed dredging methods, including blasting, and the risks posed to manatees and sea turtles from these methods.

Ms. Jasmine Raffington
April 19, 2001
Page 2

We will also be reviewing this project when it is submitted as a permit and can provide specific recommendations at that time. If you have any questions regarding these comments, please contact me or Ms. Carol Knox at (850) 922-4330.

Sincerely,

Brian Barnett, for

Bradley J. Hartman, Director
Office of Environmental Services

BJH/CAK
ENV 7-2/1/3/2
cc: U.S. Army Corps of Engineers, Jacksonville
USFWS-Vero Beach, Chuck Sultzman

A:\sai0126c.doc

850 Eller Drive □ Port Everglades, Florida 33316 □ (954) 463-2801 □ Fax (954) 467-5418

PORT EVERGLADES ASSOCIATION, INC.

April 18, 2001

Mr. Bradd Schwichtenberg
US Army Corps of Engineers
Jacksonville District
Planning Division
PO Box 4970
Jacksonville, FL 32232

Mr. Schwichtenberg:

The Port Everglades Association Board of Directors is aware of the Environmental Impact Study currently underway as a part of the Feasibility Study on the expansion of the Port Everglades waterway.

It is imperative that this port be able to accommodate the anticipated growth in the near and distant future. Therefore we are very much in favor of the expansion program and the generation of this Environmental Impact Statement draft.

As Executive Director of the 75-member Port Everglades Association I can assure that the members are extremely supportive of this expansion proposal.

Sincerely,

Margaret Kempel

Margaret Kempel
Executive Director

DISCOVERY CRUISE LINE®

April 10, 2001

Mr. Bradd Schwichtenberg
U.S. Army Corps of Engineers
Jacksonville District
Planning Division
P.O. Box 4970
Jacksonville, FL 32232

Dear Mr. Schwichtenberg:

Discovery has been a daily Port user in Port Everglades since the 1980's and we are planning to operate from Port Everglades for many years to come.

However, as of late, the growth of the Port increasingly necessitates for our unique Ro-Ro Cruise Ferry Operation to be shifted to Port locations not equally conducive.

It is therefore with great expectations that we applaud the Ports Global Expansion Movement and the feasibility study to be conducted by the COE is a major step in that direction. While environmental impact remains one of the major concerns when targeting the immense project of widening and deepening an entire Port, the ultimate necessity of the project deserves to be awarded equal concern however. In this spirit, Discovery is looking forward to a swift and favorable completion of this feasibility study.

Thank you and best regards,

Hanns J. Hahn
General Manager

Cc: Allan D. Sosnow

Administration/Hanns/memos 2001/Port Everglades Schwichtenberg

1775 N.W. 70th Avenue Miami, Florida 33126-1341 Phone (305) 597-0336 Fax (305) 477-2867/436-9712

PORT EVERGLADES

Florida's Deepest Harbor

PORT EVERGLADES PILOTS' ASSOCIATION
Post Office Box 13017
PORT EVERGLADES, FLORIDA 33316
Telephone (954) 522-4491 / 7
Facsimile (954) 522-4498

April 9, 2001

Mr. Bradd Schwichtenberg
U.S. ARMY CORPS OF ENGINEERS
Jacksonville District
Planning Division
P.O. Box 4970
Jacksonville, FL 32232

Re: Draft Environmental Impact Study

Dear Mr. Schwichtenberg:

On behalf of the Port Everglades Pilots' Association, please note that we are very much in favor of the dredging project for Port Everglades.

The benefits to the people of Florida and our country's economy cannot be underestimated.

We stand ready to offer any and all assistance that you may require.

Yours truly,

Captain Brian F. Hanley, Co-Managing Pilot

Captain Michael J. Cunningham, Co-Managing Pilot
Port Everglades Pilots' Association

BFH:ljb

cc: File

President Arthur Coffey

Secretary/Treasurer Cornelius Vanderwyde
Vice President Gerardo Becerra

Local 1922
1610 PORT BOULEVARD
MIAMI, FLORIDA 33132
Telephone: 305-379-8694

International Longshoremen's .... Association ....

Affiliated with AFL-CIO and Canadian Labour Congress

REG. U. S. PATENT OFFICE

April 5, 2001

Mr. Bradd Schwichtenberg
U.S. Army Corps of Engineers
Jacksonville District
Planning Division
P.O. Box 4970
Jacksonville, FL 32232

Dear Mr. Schwichtenberg:

This is to inform you that the International Longshoremen's Association Local 1922 does support your study of Port Everglades of the Outer and Inner Entrance Channels, the three (3) Turning Basins and the Southport Access Channel. We feel that any improvement to Port Everglades to make the facilities more compatible of the world's shipping entrance will promote jobs and a wider future to the port.

Thanking you for your time and attention.

Sincerely,
ILA Local 1922
(AFL-CIO)

Arthur Coffey
President

South
Florida
Regional
Planning
Council

April 16, 2001

Ms. Cherie Trainor
Florida Coastal Management Program
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100

RE: SFRPC #01-0332, SAI #FL200103150126C - Request for comments on the Notice of Intent to prepare a draft Environmental Statement for the Port Everglades Harbor Feasibility Study of Navigation Improvements, Department of the Army. Broward County.

Dear Ms. Trainor:

We have reviewed the above-referenced notice and have the following comments:

- Council staff finds that the Notice of Intent to prepare a draft Environmental Statement for the Port Everglades Harbor Feasibility Study of Navigation Improvements is generally consistent with the goals and policies of the *Strategic Regional Policy Plan for South Florida*, specifically the following:

Strategic Regional Goal

3.1 Eliminate the inappropriate uses of land by improving the land use designations and utilize land acquisition where necessary so that the quality and connectedness of Natural Resources of Regional Significance and suitable high quality natural areas is improved.

Regional Policies

3.1.1 Natural Resources of Regional Significance and other suitable natural resources shall be preserved and protected. Mitigation for unavoidable impacts will be provided either on-site or in identified regional habitat mitigation areas with the goal of providing the highest level of resource value and function for the regional system. Endangered faunal species habitat and populations documented on-site shall be preserved on-site. Threatened faunal species and populations and species of special concern documented on-site, as well as critically imperiled, imperiled and rare plants shall be preserved on-site unless it is demonstrated that off-site mitigation will not adversely impact the viability or number of individuals of the species.

3.1.2 Direct inappropriate uses of land that are not consistent with the protection and maintenance of natural resource values away from Natural Resources of Regional Significance and suitable natural resource areas.

3.1.3 Continue to identify and evaluate the resources of the region, including regional mitigation areas, through project reviews and required monitoring so that additional Natural Resources of Regional Significance may be designated, defined and mapped. Propose new natural resources for inclusion in, and designation by, the SRPP as they are identified, or by 1999.

e-mail sfadmin@sfrpc.com

3.1.9 Degradation or destruction of Natural Resources of Regional Significance, including listed species and their habitats will occur as a result of a proposed project only if :

a) the activity is necessary to prevent or eliminate a public hazard, and
b) the activity is in the public interest and no other alternative exists, and
c) the activity does not destroy significant natural habitat, or identified natural resource values, and
d) the activity does not destroy habitat for threatened or endangered species, and
e) the activity does not negatively impact listed species that have been documented to use or rely upon the site.

Strategic Regional Goal

3.8 Enhance and preserve natural system values of South Florida's shorelines, estuaries, benthic communities, fisheries, and associated habitats, including but not limited to, Florida Bay, Biscayne Bay and the coral reef tract.

Regional Policies

3.8.1 Enhance and preserve natural shoreline characteristics through requirements resulting from the review of proposed projects and in the implementation of ICE, including but not limited to, mangroves, beaches and dunes through prohibition of structural shoreline stabilization methods except to protect existing navigation channels, maintain reasonable riparian access, or allow an activity in the public interest as determined by applicable state and federal permitting criteria.

3.8.2 Enhance and preserve benthic communities, including but not limited to seagrass and shellfish beds, and coral habitats, by allowing only that dredge and fill activity, artificial shading of habitat areas, or destruction from boats that is the least amount practicable, and by encouraging permanent mooring facilities. Dredge and fill activities may occur on submerged lands in the Florida Keys only as permitted by the Monroe County Land Development Regulations. It must be demonstrated pursuant to the review of the proposed project features that the activities included in the proposed project do not cause permanent, adverse natural system impacts.

3.8.3 As a result of proposed project reviews, include conditions that result in a project that enhances and preserves marine and estuarine water quality by:

a) improving the timing and quality of freshwater inflows;
b) reducing turbidity, nutrient loading and bacterial loading from wastewater facilities and vessels;
c) reducing the number of improperly maintained stormwater systems; and
d) requiring port facilities and marinas to implement hazardous materials spill plans.

3.8.4 Enhance and preserve commercial and sports fisheries through monitoring, research, best management practices for fish harvesting and protection of nursery habitat and include the resulting information in educational programs throughout the region. Identified nursery habitat shall be protected through the inclusion of suitable habitat protective features including, but not limited to:

a) avoidance of project impacts within habitat area;
b) replacement of habitat area impacted by proposed project; or
c) improvement of remaining habitat area within remainder of proposed project area.

3.8.5 Enhance and preserve habitat for endangered and threatened marine species by the preservation of identified endangered species habitat and populations. For threatened species or species of critical concern, on-site preservation will be required unless it is demonstrated that off-site mitigation will not adversely impact the viability or number of individuals of the species.

3.8.6 Development of meaningful best management practices for fish harvesting.

Thank you for the opportunity to comment. We would appreciate being kept informed on the progress of this project. Please do not hesitate to call if you have any questions or comments.

Sincerely,

Eric Silva
Senior Planner

ES/jg

cc: Steve Somerville, BC-DPEP
The Honorable Jim Naugle, Cityof Fort Lauderdale
Jaye Epstein, City of Hollywood Community Development

COUNTY: Broward

Message:

DATE: 03/15/2001
COMMENTS DUE DATE: 04/13/2001
CLEARANCE DUE DATE: 04/27/2001
SAI#: FL200103150

STATE AGENCIES	WATER MANAGEMENT DISTRICTS	OPB POLICY UNITS
Community Affairs Environmental Protection Fish & Wildlife Conserv. Comm State X Transportation	South Florida WMD	Environmental Policy/C & ED

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evalutation and is categorized as one of the following:

___ Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.

_X_ Direct Federal Activity (15 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.

___ Outer Continental Shelf Exploration, Development or Production Activities (15 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.

___ Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.

Project Description:

Department of the Army - District Corps of Engineers - Notice of Intent to Prepare Draft Environmental Impact Statement (DEIS) - Port Everglades Harbor - Feasibility Study of Navigation Improvements - Fort Lauderdale, Broward County, Florida.

To: **Florida State Clearinghouse**
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100
(850) 922-5438 (SC 292-5438)
(850) 414-0479 (FAX)

EO. 12372/NEPA

- [x] No Comment
- [ ] Comments Attached
- [ ] Not Applicable

Federal Consistency

- [x] No Comment/Consistent
- [ ] Consistent/Comments Attached
- [ ] Inconsistent/Comments Attached
- [ ] Not Applicable

From:
Division/Bureau: FDOT, D4

MAR-23-2001 09:05 SFWMD REG 1 561 682 6896 P.02/02

COUNTY: Broward

DATE: 03/15/2001
COMMENTS DUE DATE: 04/13/2001
CLEARANCE DUE DATE: 04/27/2001
SAI#: FL2001031501

Message:

STATE AGENCIES	WATER MANAGEMENT DISTRICTS	OPB POLICY UNITS
Community Affairs Environmental Protection Fish & Wildlife Conserv. Comm State Transportation	X South Florida WMD	Environmental Policy/C & ED

RECEIVED MAR 22 2001 ERR-4210

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evalutation and is categorized as one of the following:

___ Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.

_X_ Direct Federal Activity (15 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.

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Project Description:

Department of the Army - District Corps of Engineers - Notice of Intent to Prepare Draft Environmental Impact Statement (DEIS) - Port Everglades Harbor - Feasibility Study of Navigation Improvements - Fort Lauderdale, Broward County, Florida.

To: **Florida State Clearinghouse**
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EO. 12372/NEPA

☐ No Comment
☐ Comments Attached
☐ Not Applicable

Federal Consistency

☐ No Comment/Consistent
☐ Consistent/Comments Attached
☐ Inconsistent/Comments Attached
☒ Not Applicable

UNDER THE OPERATING AGREEMENT BETWEEN DEP AND THE SFWMD, THIS PROJECT WILL BE REVIEWED BY DEP.

From:
Division/Bureau: ERR

Department of Environmental Protection

Jeb Bush
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

David B. Stru
Secretary

April 13, 2001

RECEIVED
19 2001
State of Florida Clearinghouse

Ms. Jasmin Raffington
Florida State Clearinghouse
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, Florida 32399-2100

Re: Department of the Army, District Corps of Engineers, Notice of Intent to Prepare Draft Environmental Impact Statement (DEIS), Port Everglades Harbor, Feasibility Study of Navigation Improvements, Ft. Lauderdale, Broward County

SAI: FL 200103150126C

Dear Ms. Raffington:

The Department has been working extensively with the Corps of Engineers and providing comments an concerns related to environmental impacts in the vicinity of Port Everglades. The following comments a... in addition to those already communicated, and noted in the public record. These additional comments are offered to further assist the Corps in its preparation of the Environmental Impact Statement.

Waste Cleanup Issues:

According to the Notice of Intent, the project is to "Widen and deepen every major Federal channel and basin within the project and develop (widen and deepen) the Dania Cutoff Canal." In addition to the general issues already identified, the Department has additional concerns relative to the sediments in areas to be dredged.

The EIS should outline the intended methods of testing sediments for contamination with identification of evaluative criteria. It is anticipated that some areas will be contaminated with fuel and metal related contaminants which can have varying effects on environmental resources. It is recommended that the Department's report entitled "1994 Florida Sediment Quality Assessment Guidelines (SQAGs)" be used as a reference for sediment analysis. This report was prepared to provide the Florida Department of Environmental Protection with biological effects-based sediment quality assessment guidelines (SQAGs) for Florida coastal waters.[1]

[1] A variety of approaches were reviewed and evaluated for deriving numerical SQAGs. Preliminary SQAGs for 34 priority substances in Florida coastal waters were derived and evaluated using an approach recommended by Long and Morgan (1990; National Oceanic and Atmospheric Administration). These SQAGs are intended to assist sediment quality assessment applications, such as identifying priority areas for non-point source management actions, designing wetland restoration projects, and monitoring trends in environmental contamination. Sediment information can be viewed at the following wet http://www.dep.state.fl.us/dwm/ documents/sediment/default.htm.

The EIS will need to describe how the dredged sediments will be managed. The proposed disposal area needs to be identified and described, and in the event that sediment contamination exceeds acceptable criteria, a plan of action will need to address how the disposal issues will be resolved. The Department's Southeast District Office Waste Cleanup Section believes that contamination sources exist near the Dania Cut off canal, in the vicinity of the marina near I-95 and the Southwest portion of the Fort Lauderdale/ Hollywood International Airport. The EIS will need to discuss the method of dealing with this contamination, if encountered.

The EIS should also describe how this project will be coordinated with the proposed expansion of the Fort Lauderdale/Hollywood International Airport. The department provided extensive comments on the proposed airport expansion and potential groundwater contamination that could impact the expansion project (see attached letter, dated March 20, 2001). As that project develops, there may be additional comments and concerns revealed by the required groundwater assessment and cleanup program. Questions and information related to groundwater contamination issues should be directed to Mr. Paul Wierzbicki at 561/681-6677, Suncom 226-6677.

Petroleum Storage Issues:

The major concern of the Bureau of Petroleum Storage Systems (BPSS) at the Port Everglades Harbor is the integrity of the sea wall adjacent to the petroleum terminal facility area. Those facilities are in proximity to, and bordering along, the Florida Power and Light Company canal, and extend northward to include Slip Numbers 1, 2 and 3. The ability of the sea wall to act as a barrier to contaminated groundwater movement is part of a Risk Assessment Approval Order, dated June 6, 1995. That Order acts as a mechanism that specifies Alternative Cleanup Target Levels used for site closure in accordance with Rule 62-770.650, F.A.C. Therefore, consideration should be given to any construction activity that may prevent the sea wall from acting as a barrier to retain contaminated substances. Activities of concern are those that would allow groundwater movement through or under the sea wall. Please contact Mr. Matthew McCoy at (850) 921-9038 if you have questions related to petroleum storage and cleanup.

If you have questions regarding this letter, or if we may be of further assistance at this time, please give me a call at (850) 487-2231.

Sincerely,

Robert W. Hall
Office of Intergovernmental Programs

Attachment
cc: Cheryl McKee
Paul Wierzbicki
Linda Frohock
Tom McCoy
Tom Seal
Mark Latch
Roxane Dow

Department of Environmental Protection

Jeb Bush
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

David B. Stru
Secretary

March 20, 2001

Ms. Cherie Trainor
Florida State Clearinghouse
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, Florida 32399-2100

Re: U.S. Department of Transportation, FAA, Draft Environmental Impact Statement, Expansion of Runway 9R-27L, Ft. Lauderdale – Hollywood International Airport, Broward County.

SAI: FL 200102090064C

Dear Ms. Trainor:

We have reviewed the above-referenced project and offer the following comments.

Air Resources:

The statement on page 5-22 related to the two NOx budgets, indicating that aircraft and vehicle emissions can be combined to offset exceedances to meet the SIP budget, is somewhat misleading. While this may be true, there is no documentation showing that the current projected NOx vehicle emissions will remain as projected. The county's transportation system is undergoing many changes and the projected NOx surplus that is needed to offset the potential aircraft NOx exceedance may not be available. Compliance with the SIP budget should be through a conformity determination by the Metropolitan Planning Organization (MPO).

This draft document presents underestimates of the VOC, NOx, and CO emissions. The figures presented in the 1997 Emissions Inventory for this particular airport were:

VOC	2,589 lbs/day
NOx	5,237 lbs/day
CO	10,352 lbs/day

The information provided in the draft document is for years 2005 and 2015. The applicant needs to explain how these projections were derived. The baseline year, numbers and sources of information need to be identified.

Using the same 44% increment in emissions that have been estimated from year 2005 to 2015 and using 1997 emissions inventory estimates from Broward County, the projections are within 88% of the VOC SIP budget for year 2015. The NOx projections are within 97% of the SIP budget be exceeded. These conclusions are based on the Summary of Impacts table presented in page xxi.

If there has been an Air Quality Analysis presented for the entire airport site it is not apparent. Such analysis needs to be included in the evaluation report. Also, staff would like to review the supporting documentation used to derive Air Quality as well as the numbers from the different models that were used for emissions projections.

The figures on page 5-23 based on the aircraft emissions inventory for 1997, provided in the Florida DEP 1993 Revisions to the SIP, do not agree with the numbers presented in the 1997 Emissions Inventory for Broward County." This discrepancy should be clarified.

Waste Cleanup Comments:

In addition to the description given in the third paragraph, the reference to 62-520.400, Florida Administrative Code (F.A.C.) regarding Minimum Criteria for Ground Water, is also applicable.

Figure 5-17 should be supplemented with the latest Broward County wellfield protection map, which is available through the Broward County Department of Planning and Environmental Protection.

The applicant needs to characterize the current and historic water quality of the discharges "through the various drainage ditches and culverts" to the Dania Cut-off Canal as well as discharges from the northwest area of the airport, and other areas of discharge. Of particular concern would be fuel related and metals parameters. The applicant needs to identify the agency or Department that has been historically responsible for the permitting, collection, and review of sampling data. If not already accomplished, a plan needs to be developed for the collection of "background" surface water quality samples.

On Page 5-35, last paragraph, the legend of Figure 5-21 states that "...known contamination at FLL has been or is properly being addressed with respect to the requirements of the regulatory agencies" is not correct. The Department has significant outstanding issues with the completion of the assessment follow-up, subsequent monitoring as well as the need for remedial action. The Department will be seeking a Consent Order or other administrative remedy that will commit the Broward County Aviation Department to fully assess alleged on and off-site contamination at the West and South sides of the airport as referenced on Figure 5-21. Our experience shows that environmental contamination assessment and cleanup issues may take several years to resolve. Therefore, any potential environmental contamination issues must be part of construction planning.

Prior to any construction and during any planning effort, it is important to determine the historic uses of buildings or areas at the airport in order to accurately assess environmental contamination issues. For example, without adequate controls, it is not acceptable to begin a demolition and dewatering project. Dewatering and construction demolition has the potential of spreading contamination to previously uncontaminated areas or exacerbating an existing cleanup. Unfortunately, this was not the strategy practiced by Miami International Airport in the early stages in its expansion project, and considerable time delays and funding considerations complicated their construction plans. In addition, there is a potential public and worker expos liability when constructing in areas of known contamination. Detailed historic plans for the airport should be obtained, including the locations of suspected hazardous materials handling areas, drain fields, pipelines, fuel lines, storm water conveyances, storage tanks, treatment tanks, weapons ordinance, and other potential sources of contamination in the area.

We are aware of facility diagrams related to the former Fort Lauderdale Naval Air Station that show the existence of storage tanks, treatment tanks, maintenance areas, and other areas of potential contamination. These specific areas should be given some level of follow-up for sampling and assessment. It should not be assumed that just because the facilities are 50 years old, that remnants of previous operations and sources of contamination no longer exist. It is recommended that a figure with sufficient detail be prepared which overlays prior Navy operations with the current facility diagram, as well as a diagram of the proposed facility expansion project.

Please describe the status of the suspected Navy dump site shown in Figure 5-29, and explain why it was not included in Figure 5-19. It is DEP's position that the current landowner is responsible for the assessment and cleanup of hazardous materials contamination on lands owned, especially if there is a potential to affect surface and groundwater quality. The Broward County Aviation Department needs to identify potentially contaminated sites, and initiate preliminary contamination assessments, through either the Broward County Department of Planning and Environmental Protection or the Department of Environmental Protection.

Please describe specific steps that are now being taken to plan for the "finding" of environmental contamination when construction is initiated. For example, what plans will be in place when a previously unknown storage tank or drainfield is located during building remodeling or demolition?

Please locate the old landfill areas that are east of US 1 on a facility map or diagram. To reiterate, dewatering would be restricted in areas of known or suspected groundwater contamination.

General Comments and Recommendations:

Although the environmental resource permit (ERP) application will be processed by the South Florida Water Management District (SFWMD), pursuant to our interagency agreement, it is recommended that the SFWMD confer with this Department's ERP staff in the Southeast District office in West Palm Beach. Such consultation would help provide continuity on the historical perspective of previous airport activities and expansion efforts. The project appears to have the potential to adversely impact environmental resources, and the applicant will be required to avoid and minimize those impacts to the greatest extent practicable. After avoidance and minimization has been exhausted, the applicant will need to propose mitigation that will offset those impacts.

Based on the concerns outlined above, it is recommended that the applicant confer with the department's Southeast District Office on air and waste management issues, and provide the requested information that will allow a more accurate assessment of the proposed project. The issues raised above will be important considerations as the project design is developed. The project will be re-evaluated for consistency with the Department's authorities in the Florida Coastal Management Program on review of any subsequent reports, studies or environmental documents.

We appreciate the opportunity of commenting on this proposal. Questions related to the management of potential air pollution exceedances should be referred to Mr. Bruce Offord in our Southeast District Office at 561/681-6600 or Suncom 226-6677. Questions of a waste management nature should be referred to Mr. Paul Wierzbicki at 561/681-6677 or Suncom 226-6677. If you have questions regarding this letter please give me a call at (850) 487-2231.

Sincerely,

Robert W. Hall
Office of Intergovernmental
Programs

cc: Jim Golden
Cheryl McKee
Bruce Offord
Paul Wierzbicki
Don Keirn

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P. O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF
Planning Division
Environmental Branch

MAR 0 5 2001

TO WHOM IT MAY CONCERN:

Pursuant to the National Environmental Policy Act and the U.S. Army Corps of Engineers Regulation (33 CFR 230.12), this letter constitutes the Notice of Intent to prepare a Draft Environmental Impact Statement (DEIS) for the Port Everglades Harbor, Feasibility Study of Navigation Improvements, Fort Lauderdale, Broward County, Florida. This letter also constitutes announcement of a public scoping meeting to be held at 7 p.m., Wednesday, March 28, 2001. The public scoping meeting will be held at the Commission Chambers, in downtown Fort Lauderdale, located at 115 South Andrews Avenue. A location and vicinity map for the public scoping meeting is enclosed. The purpose of the meeting is to help to determine the scope of the EIS that will be prepared for this project. Public comments will be recorded by a Court reporter and comments may be submitted in writing for 30 days following the meeting.

Sincerely,

James C. Duck

James C. Duck
Chief, Planning Division

Enclosures

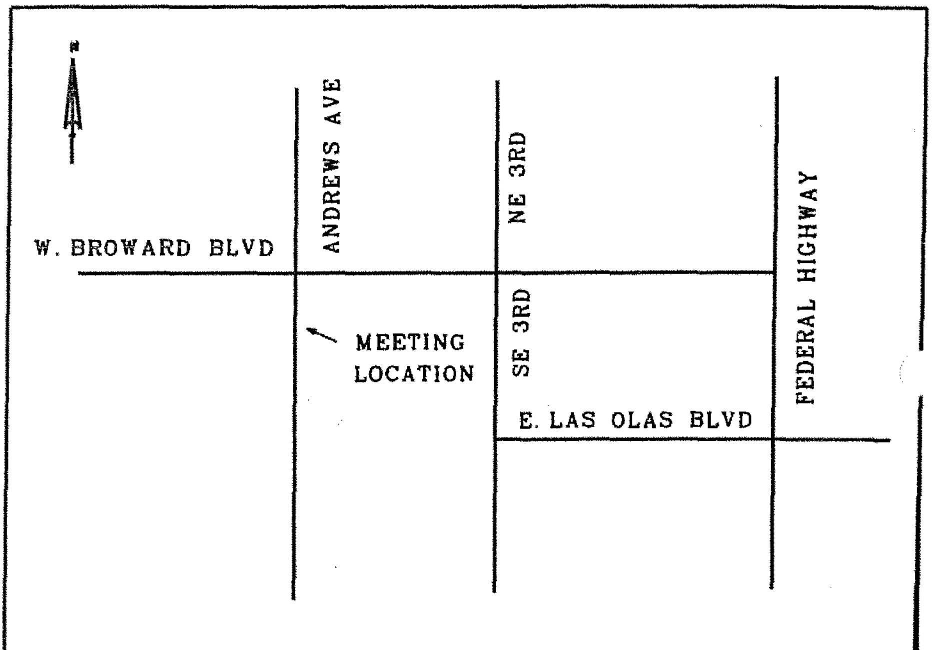


FIGURE 1: PUBLIC MEETING LOCATION MAP

...\pub mtg.dgn 03/02/01 03:24:51

Scoping Meeting on
Port Everglades
Commission Chambers
115 South Andrews Avenue
Ft. Lauderdale, Florida

The Miami Herald

www.herald.com
www.elherald.com

PUBLISHED DAILY
MIAMI-DADE-FLORIDA

STATE OF FLORIDA
COUNTY OF DADE

Before the undersigned authority personally appeared:

JEANNETTE MARTINEZ

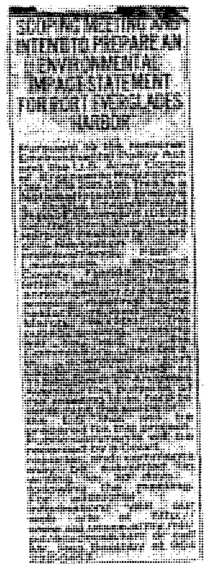
who on oath says that he/she is

CUSTODIAN OF RECORDS

of The Miami Herald, a daily newspaper published at Miami in Dade County, Florida; that the attached copy of advertisement was published in said newspaper in the issues of:

March 16, 2001

Affiant further says that the said The Miami Herald is a newspaper published at Miami, in the said Dade County, Florida and that the said newspaper has heretofore been continuously published in said Dade County, Florida each day and has been entered as second class mail matter at the post office in Miami, in said Dade County, Florida, for a period of one year next preceding the first publication of the attached copy of advertisement; and affiant further says that he has neither paid nor promised any person, firm or corporation any discount, rebate, commission or refund for the purpose of securing this advertisement for publication in the said newspapers(s).


SCOPING MEETING AND INTENT TO PREPARE AN ENVIRONMENTAL IMPACT STATEMENT FOR PORT EVERGLADES HARBOR

[illegible]

Sworn to and subscribed before me this
___16th__ day of ____March_________, 2001

My Commission
Expires: ____May 12, 2002____________
Silvia Acosta

Notary

OFFICIAL NOTARY SEAL

SUN-SENTINEL

PUBLISHED DAILY
FORT LAUDERDALE, BROWARD COUNTY, FLORIDA
BOCA RATON, PALM BEACH COUNTY, FLORIDA
MIAMI, MIAMI DADE COUNTY, FLORIDA

STATE OF FLORIDA
COUNTY OF BROWARD/PALM BEACH/MIAMI DADE
BEFORE THE UNDERSIGNED AUTHORITY, PERSONALLY APPEARED

Chris Bull ________________ WHO, ON OATH, SAYS THAT HE/SHE IS A DULY AUTHORIZED REPRESENTATIVE OF THE CLASSIFIED DEPARTMENT OF THE SUN-SENTINEL, DAILY NEWSPAPER PUBLISHED IN BROWARD/PALM BEACH/MIAMI DADE COUNTY, FLORIDA, AND THAT THE ATTACHED COPY OF ADVERTISEMENT, BEING A:

NOTICE

IN THE MATTER OF:

Public Scoping Meeting

IN THE CIRCUIT COURT, WAS PUBLISHED IN SAID NEWSPAPER IN THE ISSUES OF:

3/17,1d 10291949

AFFIANT FURTHER SAYS THAT THE SAID SUN-SENTINEL IS A NEWSPAPER PUBLISHED IN SAID BROWARD/PALM BEACH/MIAMI DADE COUNTY, FLORIDA, AND THAT THE SAID NEWSPAPER HAS HERETOFORE BEEN CONTINUOUSLY PUBLISHED IN SAID BROWARD/PALM BEACH/MIAMI DADE COUNTY, FLORIDA, EACH DAY, AND HAS BEEN ENTERED AS SECOND CLASS MATTER AT THE POST OFFICE IN FORT LAUDERDALE, IN SAID BROWARD COUNTY, FLORIDA, FOR A PERIOD OF ONE YEAR NEXT PRECEDING THE FIRST PUBLICATION OF ATTACHED COPY OF ADVERTISEMENT; AND AFFIANT FURTHER SAYS THAT HE/SHE HAS NEITHER PAID, NOR PROMISED, ANY PERSON, FIRM, OR CORPORATION, ANY DISCOUNT, REBATE, COMMISSION, OR REFUND, FOR THE PURPOSE OF SECURING THIS ADVERTISEMENT FOR PUBLICATION IN SAID NEWSPAPER.

Chris Bull
(SIGNATURE OF AFFIANT)

SWORN TO AND SUBSCRIBED BEFORE ME
ON: **17-March-2001** , A.D.

Tara L. Bezak
(SIGNATURE OF NOTARY PUBLIC)

Tara L. Bezak
MY COMMISSION # CC638935 EXPIRES
July 20, 2001
BONDED THRU TROY FAIN INSURANCE, INC

(NAME OF NOTARY, TYPED, PRINTED, OR STAMPED)

PERSONALLY KNOWN ________________ OR

PRODUCED IDENTIFICATION ________________

NOTICE OF PUBLIC SCOPING MEETING AND INTENT TO PREPARE AN ENVIRONMENTAL IMPACT STATEMENT FOR PORT EVERGLADES HARBOR

[illegible]

MAILING LIST - GENERAL

FEDERAL AGENCIES

Director
Office of Federal Activities
Environmental Protection Agency
401 M Street S.W.
Washington, D. C. 30034-2610 (5 cys)

Environmental Policy Section
U.S. Environmental Protection Agency
Region IV
Atlanta Federal Center
100 Alabama St., S.W.
Atlanta, Georgia 30303-3104 (2 cys)

Director
Office of Environmental Project Review
Department of the Interior
Room 4241
18th and C Streets, NW
Washington, D.C. 20240 (12 cys)

Executive Director
Advisory Council on Historic Preservation
The Old Post Office Building
1100 Pennsylvania Avenue N.W.
Washington, D.C. 20004-2590

National Marine Fisheries Service
Environmental Assessment Branch
3500 Delwood Beach Road
Panama City, Florida 32407-7499

National Marine Fisheries Service
Southeast Regional Office
9721 Executive Center Drive N
St. Petersburg, Florida 33702

National Marine Fisheries Service
Chief, Protected Species Branch
9721 Executive Center Drive N
St. Petersburg, Florida 33702

Mr. Tom Grahl
Acting Field Supervisor
U.S. Fish and Wildlife Service
P.O. Box 2676
Vero Beach, Florida 32961-2676

Mr. David Hankla
Field Supervisor
U.S. Fish and Wildlife Service
6620 Southpoint Drive S
Suite 310
Jacksonville, Florida 32217

Commander
Seventh Coast Guard District
909 SE 1st Avenue
Miami, Florida 33131-3050

Office of Environmental Assessment
U.S. Environmental Protection Agency
EPA Region IV
Attn: Gerald Miller
61 Forsyth Street
Atlanta, Georgia 30303-3104 (3 cys)

STATE AGENCIES

Florida State Clearinghouse
The Dept. of Community Affairs
2555 Shumard Oak Blvd.
Tallahassee, Florida 32399-2100 (16 cys)

St. Johns River Water Management District
P.O. Box 1429
Palatka, Fla. 32178-1428

w/boothby/maillist

OTHER AGENCIES AND ORGANIZATIONS

Florida Chapter, Sierra Club
927 Delores Drive

Florida Wildlife Federation
P.O. Box 6870

Tallahassee, Florida 32301-2929

Florida Audubon Society
1101 Audubon Way
Maitland, Fla. 32751-5451

The Nature Conservancy
222 S. Westmonte Dr.
Suite 300
Altamonte Springs, Fl. 32714-4269

Mr. David Roach
F.I.N.D.
1314 Marcinski Rd.
Jupiter, Fl. 33477

Capt. Don Stratmann
Florida Marine Patrol
2510 Second Avenue N.
Jacksonville, Fl 32250

Tallahassee, Florida 32314-6870

Isaac Walton League of America, Inc.
5314 Bay State Road
Palmetto, Fla 33561-9712

Wilderness Society
4203 Ponce DeLeon Blvd.
Coral Gables, Florida 33416

W/boothby/maillist

Coordination Act consultation procedures. Consultation will also be accomplished with the USFWS and the National Marine Fisheries Service concerning threatened and endangered species. All other necessary environmental compliance will be obtained before a Record of Decision on the EIS is signed. Other compliance requirements include a Clean Water Act Section 404(b)(1) evaluation, a Louisiana Coastal Resources Program Consistency Determination, and a State Water Quality Certification. The draft EIS or a notice of its availability will be distributed to all interested agencies, organizations, and individuals.

7. *Estimated Date of Availability.* The draft EIS is expected to be available in mid-2003.

Gregory D. Showalter,
Army Federal Register Liaison Officer.
[FR Doc. 01–7260 Filed 3–22–01; 8:45 am]
BILLING CODE 3710–84–U

DEPARTMENT OF DEFENSE

Department of the Army, Corps of Engineers

Intent To Prepare a Draft Environmental Impact Statement (DEIS) for a Feasibility Study of Navigation Improvements at Port Everglades, Broward County, FL

AGENCY: U.S. Army Corps of Engineers, DoD.

ACTION: Notice of intent.

SUMMARY: The Jacksonville District, U.S. Army Corps of Engineers intends to prepare a Draft Environmental Impact Statement (DEIS) for the Feasibility Study of Navigation Improvements, Port Everglades Harbor, Broward County, Florida. The study is a cooperative effort between the U.S. Army Corps of Engineers and the Broward County Department of Port Everglades.

FOR FURTHER INFORMATION CONTACT: Questions about the proposed action can be directed to Rea Boothby at (904) 232–3453, Environmental Branch, Planning Division, P.O. Box 4970, Jacksonville, Florida 32232–0019.

SUPPLEMENTARY INFORMATION:

1. *Project Background and Authorization.* Port Everglades was originally constructed by local interests between 1925–1928, and was authorized for Federal maintenance by the River and Harbor Act of 1930 and subsequent Acts.

2. *Need or Purpose.* Improvements, including channel deepening and widening, are required to accommodate future commercial fleet and to more effectively transit the existing fleet.

3. *Proposed Solution and Forecast Completion Date.* Widen and deepen every major Federal channel and basin within the project and develop (widen and deepen) the Dania Cutoff Canal. Construction is forecast to begin around March 2003.

4. *Prior Environmental Assessments (EAs) EISs.* An EA was prepared in 1990 to accommodate dredging in the Southport access channel and Turning Notch.

5. *Alternatives.* Alternatives currently considered include no action, and 9 structural alternatives.

6. *Issues.* The EIS will consider impacts on seagrasses (including Johnson Seagrass, a threatened species), mangrove and hardbottom communities, other protected species, shore protection, health and safety, water quality, aesthetics and recreation, fish and wildlife resources, cultural resources, energy conservation, socio-economic resources, and other impacts identified through scoping, public involvement, and interagency coordination.

7. *Scoping Process.*

a. A scoping letter was sent to interested parties in June 1997. In addition, all parties are invited to participate in the scoping process by identifying any additional concerns on issues, studies needed, alternatives, procedures, and other matters related to the scoping process.

b. Public Meeting. A public scoping meeting will be held on March 28, 2001 at 7 P.M. in the Broward County Commission Chambers located at 115 South Andrews Avenue, Ft. Lauderdale, FL. An agency scoping meeting will be held on March 29, 2001 at Port Everglades.

8. *Public Involvement:* We invite the participation of affected Federal, state and local agencies, affected Indian tribes, and other interested private organizations and parties.

9. *Coordination.* The proposed action is being coordinated with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act, with the FWS under the Fish and Wildlife Coordination Act, with the NMFS concerning Essential Fish Habitat and the State Historic Preservation Officer.

10. *Other Environmental Review and Consultation.* The proposed action would involve evaluation for compliance with guidelines pursuant to Section 404 (b) of the Clean Water Act; application (to the State of Florida) for Water Quality Certification pursuant to Section 401 of the Clean Water Act; certification of state lands, easements, and rights of way; and determination of the Coastal Zone Management Act consistency.

11. *Agency Role.* The Corps and the non-Federal sponsor, Broward County Department of Port Everglades, will provide extensive information and assistance on the resources to be impacted, mitigation measures, and alternatives.

12. *DEIS Preparation.* It is estimated that the DEIS will be available to the public on or about September 2001.

Gregory D. Showalter,
Army Federal Register Liaison Officer.
[FR Doc. 01–7257 Filed 3–22–01; 8:45 am]
BILLING CODE 3710–AJ–U

DEPARTMENT OF EDUCATION

Notice of Proposed Information Collection Requests

AGENCY: Department of Education.

SUMMARY: The Leader, Regulatory Information Management Group, Office of the Chief Information Officer, invites comments on the proposed information collection requests as required by the Paperwork Reduction Act of 1995.

DATES: Interested persons are invited to submit comments on or before May, 22, 2001.

SUPPLEMENTARY INFORMATION: Section 3506 of the Paperwork Reduction Act of 1995 (44 U.S.C. chapter 35) requires that the Office of Management and Budget (OMB) provide interested Federal agencies and the public an early opportunity to comment on information collection requests. OMB may amend or waive the requirement for public consultation to the extent that public participation in the approval process would defeat the purpose of the information collection, violate State or Federal law, or substantially interfere with any agency's ability to perform its statutory obligations. The Leader, Regulatory Information Management Group, Office of the Chief Information Officer, publishes that notice containing proposed information collection requests prior to submission of these requests to OMB. Each proposed information collection, grouped by office, contains the following: (1) Type of review requested, e.g. new, revision, extension, existing or reinstatement; (2) Title; (3) Summary of the collection; (4) Description of the need for, and proposed use of, the information; (5) Respondents and frequency of collection; and (6) Reporting and/or

US Army Corps
of Engineers
Jacksonville District

News Release

Release No. 0114
For Release: March 13, 2001
P.O. Box 4970 Jacksonville, FL 32232-0019

Contact: Jacquelyn Griffin, Public Affairs Officer
Phone: 904-232-1650 FAX: 904-232-2237
Email: jacquelyn.j.griffin@saj02.usace.army.mil

FOR IMMEDIATE RELEASE

CORPS SCHEDULES PUBLIC SCOPING MEETING ON DRAFT ENVIRONMENTAL IMPACT STATEMENT ON PORT EVERGLADES HARBOR

JACKSONVILLE, Fla. – The Army Corps of Engineers will hold a public scoping meeting to gather information in their preparation of a Draft Environmental Impact Statement (EIS) for the Port Everglades Harbor Feasibility Study of Navigation Improvements. The port is located in Fort Lauderdale. The study is a cooperative effort between the Army Corps of Engineers and the Broward County Department of Port Everglades

The meeting will be held at 7 p.m. on Wednesday, March 28, 2001, in the Broward County Commission Auditorium, Room 422, of the Broward County Governmental Center, 115 South Andrews Ave., Fort Lauderdale, Fla. The Corps will accept written comments for 30 days following the meeting.

The purpose of the meeting is to help determine the scope of the EIS that will be prepared for this project.

The EIS will address improvements to the harbor, including channel and basin deepening and widening, that may be required to more efficiently handle current and future shipping demands.

-MORE-

PORT EVERGLADES HARBOR PUBLIC SCOPING MEETING – Page 2/2/2

The proposed action is being coordinated with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act; the FWS under the Fish and Wildlife Coordination Act; the NMFS concerning Essential Fish Habitat and the State Historical Preservation Officer.

For further information about this meeting, the public is welcome to call Rea Boothby at 904-232-3453 or toll free at 800-291-9405. The media may call Ms. Jacquelyn Griffin, Public Affairs Officer, at 904-232-1667.

-30-

US Army Corps of Engineers
Jacksonville District

News Release

Release No. 0122-Nr2
For Release: March 22, 2001
P.O. Box 4970 Jacksonville, FL 32232-0019

Contact: Jacquelyn Griffin, Public Affairs Officer
Phone: 904-232-1650 FAX: 904-232-2237
Email: jacquelyn.j.griffin@saj02.usace.army.mil

FOR IMMEDIATE RELEASE

PORT EVERGLADES DRAFT ENVIRONMENTAL IMPACT STATEMENT SUBJECT OF MARCH 28 MEETING

JACKSONVILLE, Fla. – In a cooperative effort by the Broward County Department of Port Everglades and the Army Corps of Engineers, a public scoping meeting will be held to gather information in the preparation of a Draft Environmental Impact Statement (EIS) for the Port Everglades Harbor Feasibility Study of Navigation Improvements.

The public scoping meeting is scheduled to begin at 7 p.m. on Wednesday, March 28, 2001, in the Broward County Commission Auditorium, Room 422, of the Broward County Governmental Center, 115 South Andrews Ave., Fort Lauderdale, Fla. Written comments concerning the meeting will be accepted by the Corps for 30 days following the meeting.

The Corps and the County will use the information gathered at this meeting to help determine the scope of the EIS that will be prepared for this project.

The EIS will address channel improvements, including channel and basin deepening and widening, that may be required to more efficiently handle current

-MORE-

The proposed actions is being coordinated with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act; the FWS under the Fish and Wildlife Coordination Act; the NMFS concerning Essential Fish Habitat and the State Historical Preservation Officer.

The public may contact Rea Boothby at 904-232-3453 or toll free at 800-291-9405 for more details about this meeting. The media is welcome to call Ms. Jacquelyn Griffin, Public Affairs Officer, at 904-232-1667.

-30-

NOVA SOUTHEASTERN UNIVERSITY

Statement to the US Army Corps of Engineers & Port Everglades

By: Nova Southeastern University Oceanographic Center
Dr. Richard E. Dodge, Dean

Presentation At Port Everglades Screening Meeting
Thursday Sept. 21, 2000

Mission - The mission of the Oceanographic Center of Nova Southeastern University is to carry out innovative basic and applied research, and to provide high-quality graduate and undergraduate education in a broad range of marine science and related disciplines. The Center also serves as a community resource for information, education, and research on oceanographic and environmental issues.

Background: Founded in 1966, the Oceanographic Center has been located on a 10-acre site at Port Everglades, 8000 North Ocean Drive for over 30 years. This site was deeded to NSU by Broward County. The Oceanographic Center has a distinguished history of conducting outstanding scientific ocean research ranging from characterization of the Florida Current and Gulf Stream, El Nino causes and effects, coral reef studies, fish ecology, sea turtle renesting, plankton studies, and mangrove and wetlands investigations. Research productivity has been coupled with excellence in education in oceanography, marine biology, coastal zone management, and marine environmental studies.

Screening Criteria: Eleven preliminary alternative plans for Port Everglades deepening and widening were presented at the July 25, 2000 meeting in Jacksonville, Florida. From NSU's perspective, an alternative is acceptable for implementation if:

1) There are no adverse impacts to terrestrial and submerged land, property, and facilities (planned and existing) of Nova Southeastern University.
2) There are no adverse impacts to the ecology of the construction area. Our neighboring Park and its associated environments serve a valuable social and ecological function.

SUMMARY: The NSU Oceanographic Center conducts extensive marine biological and physical oceanographic research and educational programs. Our buildings, marina, and associated facilities provide faculty, staff, and students with offices, laboratories, classrooms, a library, and sophisticated information technology. We have plans for extensive new research and education facilities. Consequently, any channel deepening and widening alternatives which do not adversely impact the Oceanographic Center, or which do not prevent us from accomplishing our mission and realizing our vision, are acceptable. We seek an optimum configuration so that we may continue our programs of research and education and our planned growth and development.

Department of
Environmental Protection

Jeb Bush
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

David B. Struhs
Secretary

June 14, 2000

James C. Duck, Chief
Planning Division
Department of the Army
Jacksonville District Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Duck: Jim

I am in receipt of your letter of June 5, 2000, regarding the Port Everglades feasibility team. This Office supports the effort to improve early coordination between our agencies on project development. To that end, we have assigned Lauren Milligan to the Port Everglades feasibility team. Unfortunately, she will not be available for today's meeting.

Please contact Ms. Milligan directly when you schedule your next meeting. You can reach her by phone at (850) 487-4471, ext. 141, or by e-mail at lauren.milligan@dep.state.fl.us.

Sincerely,

Al

Alfred B. Devereaux, Jr., Director
Office of Beaches and Coastal Systems

ABD/ms/p
cc: Martin Seeling
Lauren Milligan

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P. O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

June 5, 2000

Planning Division
Coastal/Navigation Section

Dr. Al Devereaux
Director, Office of Beaches and Coastal Systems
Florida Department of Environmental Protection
3900 Commonwealth Boulevard
Mail Station 300
Tallahassee, Florida 32399-3000

Dear Dr. Devereaux:

A conference call was recently held between our respective staffs to discuss ways to improve Corps/FDEP project development /permit decision process for Federal Civil Works projects. It was suggested during the call that a member of your staff become a member of the Port Everglades feasibility team and actively participate in the study, including attending study team meetings.

The Port Everglades Feasibility Study was initiated in 1997. Originally the study focused on removal of two shoal areas. On April 4, 2000 the study scope was amended to include investigation of widening and deepening all of the ports channels and basins. There are numerous environmental issues related to possible expansion, deepening and/or widening of the Federal navigation project. Attached is the study schedule and project study plan. The next study team meeting is scheduled for 0930-1130 June 14, 2000 in Room G-13, Federal Building, Jacksonville, FL.

We invite your active participation in the study, and look forward to working together on this important effort.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Copy Furnished:

Mr. Allan Sosnow, Broward County Department of Port Everglades

EIS
SUB-APPENDIX B

CLEAN WATER ACT SECTION 404(b)(1)

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

Appendix B
Section 404(b)(1) Evaluation Report
Port Everglades Harbor Improvement and Maintenance Dredging
Broward County, Florida

I. PROJECT DESCRIPTION

a. Location. Port Everglades Harbor is located in Fort Lauderdale, Hollywood, and Dania Beach (Broward County) on the Atlantic coast of Florida.

b. General Description. USACE analyzed 22 alternatives (including multiple depths for various components) for the Port Everglades Feasibility Study. This Environmental Impact Statement (EIS) analyzes the environmental effects of (1) the Tentatively Selected Plan ("TSP," i.e., Alternative 2E) involving dredging the Outer Entrance Channel (OEC) to an *authorized* depth of 48 feet (up to an *actual* depth of 57 feet), (2) four other alternative dredge depths for the OEC for the TSP, and (3) the No-Action Alternative. The TSP (actual depth 57-foot OEC alternative) proposes to do the following:

1) increase the authorized depth of the OEC from 45 feet (actual existing depths vary) to 48 feet (-48 feet MLLW) (i.e., an *actual* depth of up to 57 feet due to engineering and safety requirements), widen the seaward end of it from 500 feet to 800 feet, and extend the channel 2,200 feet seaward;
2) increase the authorized depth of the Inner Entrance Channel (IEC) from 42 feet to 48 feet (resulting in an actual depth of 50 feet);
3) increase the authorized depth of the Main Turning Basin (MTB) from 42 feet to 48 feet (resulting in an actual depth of 50 feet);
4) widen the rectangular shoal region (the Widener, or "WID") by approximately 300 feet to the southeast of the MTB and deepen it to a new authorized depth of 48 feet (resulting in an actual depth of 50 feet);
5) widen the Southport Access Channel (SAC) in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 feet and relocate the United State Coast Guard (USCG) facility, a General Navigation Feature (GNF), easterly on USCG property;
6) shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition back from the expanded Widener area in the north to the existing Federal channel limits to the south;
7) increase the authorized depth of the SAC from 42 feet to 48 feet (from the area adjacent to berth 23 to the south end of berth 32), resulting in an actual depth of 50 feet;
8) deepen the Turning Notch (TN), including an area currently being expanded and incorporated into the TN by the local sponsor, from 42 feet to 48 feet (resulting in an actual depth of 50 feet); widen the SAC to the east (across from the TN) by an additional 100 feet over a length of about 1,845 feet; and widen the western edge of the SAC from near the south end of berth 29 to a width of up to approximately 130 feet at the north edge of the TN;
9) conduct environmental mitigation (see below);

10) pre-treat rock substrates as necessary and take appropriate measures to safeguard protected species during that process;

11) dispose of dredged material east of the Port at the Offshore Dredged Material Disposal Site (ODMDS), which is currently proposed for expansion by USEPA. If it is not expanded, the Corps would complete a one-time designation of a disposal site under Section 102 of MPRSA for the dredged material generated by the proposed project. The Corps would adopt the NEPA document prepared by EPA for the expansion effort.

c. Avoidance and Minimization of Impacts. Impacts to important habitat types have been reduced with each iterative set of proposed plans over that past decade of planning:

1) Mangrove wetland impacts assessed in 2001 ranged from 33 to 45 acres for various alternatives. The tentatively selected plan now proposes to impact only 1.16 acres of mangroves.

2) A substantial reduction in hardbottom impacts was achieved through the reduction of the proposed OEC "flare" on the eastern terminus. Planners reduced the width of the terminus (i.e., the width of the channel at the point where vessels would enter the channel) from 1,000 feet to 800 feet. This reduced the impacts to hardbottom and reef habitats by approximately three acres by reducing the amount of reef being permanently removed by the project.

3) Another major effort to avoid and minimize damage to reef organisms is the direct transplantation of scleractinian corals (over 10 cm in diameter or height) from the direct impact area to either nursery areas coordinated with the resource agencies or to mitigation sites, just prior to construction of the TSP. To allow for these corals to be relocated directly to the mitigation sites just prior to construction, the contractor will either install at mitigation sites purchased, quarried, native limestone, or rock produced from construction operations (i.e., pre-treatment of rock). Approximately 10,000 scleractinian corals greater than 15 cm in diameter are located in the direct impact area *of the third reef*, and 3,200 scleractinian corals greater than 15 cm in diameter are located in the direct impact area *of the second reef.* Between 12,000 and 13,000 of these corals are greater than 10 cm in diameter or height and these would be relocated to ensure that reproductively capable corals in the impact area are preserved.

4) Reductions in the project footprint size during the plan formulation process will result in the avoidance or minimization of certain impacts. Dredging in the DCC, TN and STB have been eliminated from plans. This will decrease the time of operation for construction equipment (originally estimated at four years of uninterrupted construction in 2004), and so decrease the time during which species using the Port and adjacent habitats may be directly or indirectly affected.

5) Finally, the project dredge depth has been reduced from -50 feet MLLW to -48 feet MLLW. This resulted in the reduction of approximately one acre of impacts to hardbottom resources.

d. Mitigation of Unavoidable Impacts. To compensate for the effects of the action on various habitat types, USACE has proposed the following: (a) mitigate for the removal of 4.01 acres of seagrass and (b) the loss of 1.16 acres of mangroves in the project footprint (including within the channel and resulting side slopes) through use of an on-going habitat improvement project at West Lake Park. From that project, the Federal project will be permitted to use 2.4 seagrass functional units and one (1) mangrove functional unit, respectively, due to previously permitted restoration, enhancement, and preservation of like habitats in this county-operated, state-owned natural area located to the south of the project area; (c) mitigate for the direct removal of 10.10 acres of complex, high-profile, reef habitat through the creation of approximately 12.57 acres of high-profile artificial reef habitat, and (d) mitigate for the direct removal of 5.07 acres of less complex, low-profile hardbottom habitat (including channel wall habitat and all indirect effects to adjacent hardbottom habitats) by creating 6.92 acres of low-profile hardbottom.

e. Authority and Purpose. The Port Everglades Feasibility Study is authorized through House Document 126, 103rd Congress, 1st Session, and House Document 144, 93rd Congress, 1st Session and by a resolution of the House Committee on Transportation dated May 9, 1996. The primary objectives for the project considered in the Port Everglades Feasibility Study are the following: (1) decrease costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies at Port Everglades through the year 2067; (2) decrease transportation costs through increasing economies of scale for cargo and petroleum vessels at Port Everglades through the year 2067; and (3) increase channel safety and maneuverability at Port Everglades for existing vessel use as well as for larger vessels through the year 2067.

f. General Description of Dredged or Fill Material. Material to be removed includes organic material such as peat, clay, silt, sand, and rock. Most of the material is in situ layered formations of rock and finer materials.

(1) General Characteristics of Material: The majority of materials within the project area include inter-bedded layers of sand and rock with occasional massive formations of very hard rock. Additional materials include silts, clays, and organic peat material. Sediment constituents encountered at the Port vary greatly according to core boring location and elevation.

(2) Quantity of Material: A total of 5,470,549 cy of material will be dredged over a six-year period from the project area. Most of the material will be placed in the ODMDS, and appropriate material (>2 feet in diameter) will be placed on the artificial reef site.

(3) Source of Material: The dredged material will be removed from the outer and inner entrance channels, interior basins, and access channels within Port Everglades. Material for the artificial reef creation site (approximately 100,000cy) will consist of appropriate rock from these areas as well as native limestone boulders from nearby quarries.

g. Proposed Disposal Sites. The dredged material will be placed in the ODMDS site located northeast of the Outer Entrance Channel or in the artificial reef mitigation site, as appropriate (for rock at least two feet in diameter).

h. Description of Disposal Methods. The type of dredge(s) used will affect methods used to convey the material to the disposal sites. For disposal in the ODMDS, split hull or similar barges will most likely be used. If a mechanical dredge is used, the larger dredged material may be removed and segregated at the construction site for use in constructing the hardbottom mitigation sites. Larger rock material would be placed on one barge to be transported to the mitigation site, while other materials would be placed on a separate barge/scow for placement at the offshore disposal site.

II. FACTUAL DETERMINATIONS

a. Physical Substrate Determinations.

(1). Substrate Elevations The existing depths are between approximately +10 feet and –52 feet.

(2). Sediment Type. Peat, clay, silt, sand, rock.

(3). Fill Material Movement. No movement is expected at the artificial reef site or the ODMDS site.

(4). Physical Effect on Benthos. Wherever material is placed on the substrate, the benthic inhabitants will be lost. However, rapid recovery of the benthic community is expected. The artificial reef site will replace functions lost from the impact sites.

(5). Other Effects. The artificial reef creation site will result in a beneficial effect to the marine community and recreational fishing. Potential turbidity effects are addressed below.

b. Water Circulation, Fluctuation and Salinity Determinations. Water fluctuation, circulation and salinity will not be adversely affected.

c. Suspended Particle/Turbidity Determinations.

(1). Expected Changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Disposal Sites. Except for minor disturbances at the dredging site, little turbidity is expected outside the immediate dredging area during construction; state water quality and turbidity standards will be met at all times during construction. Dredges will observe strict adherence to shut-down protocols if there is any risk to downstream water quality during construction. Turbidity levels at the ODMDS will adhere to conditions goveming use of that area.

(2). Effects (Degree and Duration) on Chemical and Physical Values

(a). Light Penetration. No long-term adverse effects to light penetration are expected in the vicinity of construction activities. A slight reduction may during dredging, but because of tidal action in the harbor these effects will be of short duration. The area deepened by dredging would have slightly less light penetration near the bottom.

(b). Dissolved Oxygen. Dissolved oxygen (DO) levels should be unaffected by construction activities.

(c). Toxic Metals and Organics. No toxic metals or organics are known to occur at the sites.

(d). Pathogens. Not applicable.

(e). Aesthetics. The presence of equipment during dredging activities will be aesthetically displeasing; however, upon completion of these activities all equipment will be removed. Therefore, there will be no long-term adverse aesthetic impacts.

d. Contaminant Determinations. No sources of pollutants or contaminants have been identified within the construction or disposal areas.

e. Aquatic Ecosystem and Organism Determinations.

(1). Effects on Plankton. No adverse impacts expected.

(2). Effect on Benthos. Benthic habitat will be lost in the construction template, but will be compensated for at the mitigation site(s). Existing benthic organisms at the artificial reef site will be lost due to replacement of that system by placement of rock materials on the substrate, but long-term population-level effects on benthic infauna in the area are not anticipated. Benthic faunal diversity is anticipated to increase in the area surrounding the mitigation reefs.

(3). Effect on Nekton. No adverse impacts expected.

(4). Effect on the Aquatic Food Web. The artificial reef creation will result in a beneficial effect to the aquatic food chain in those areas. In impact areas, foraging species may have to relocated to adjacent areas for benthic resources.

(5). Effects on Special Aquatic Sites.

(a). Sanctuaries or Refuges. No sanctuaries or refuges are located in the project area.

(b). Wetlands. 1.16 acres of mangrove habitat will be removed. Mitigation will be provided at Westlake Park.

(c). Mud Flats. No adverse impacts expected.

(d). Vegetated Shallows. 4.01 acres of seagrasses will be removed. Mitigation will be provided at Westlake Park.

(e). Reefs. A total of 15.34 acres of rock/rubble, hardbottom, or other colonized habitat will be impacted. These impacts will be mitigated at the artificial reef site.

(f). Threatened and Endangered Species. 3.57 acres of *Halophila johnsonii* (monospecific or mixed beds) will be impacted by dredging. Mitigation will be provided at Westlake Park. Protective measures for other protected species during construction including the West Indian manatee, smalltooth sawfish, and sea turtles will be implemented accordance with the Biological Opinions issued for the project.

(g). Other Wildlife. Adverse impacts to other wildlife and marine species will be minor. Where appropriate, protective and mitigative measures will be taken.

f. Proposed Disposal Site Determinations.

(1). Mixing Zone Determination. Not applicable.

(2). Determination of Compliance with Applicable Water Quality Standards. State water quality certification will be obtained for the work and applicable state water quality standards will be met during construction.

(3). Potential Effects on Human Use Characteristics. No adverse impacts expected.

(a). Municipal or Private Water Supply. No effect.

(b). Recreational and Commercial Fisheries. No adverse impacts expected.

(c). Water Related Recreation. Minor temporary adverse effects to recreation could occur during dredging operations. However, construction of the artificial reef site would result in a long-term beneficial effect to recreation.

(d). Aesthetics. The presence of construction equipment during the construction period will be unsightly; however, upon completion of construction the equipment will be removed and there will be no long-term adverse aesthetic impacts.

(e). Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites and Similar Preserves. 1.19 acres of mangrove habitat and 0.9 acres of uplands will be lost from John Lloyd State Park.

g. Determination of Cumulative Effects on the Aquatic Ecosystem. The creation of the artificial reef site would offset the loss of productivity from the impacted reef areas. 4.01 acres of seagrass will be lost with the project, but approximately 8 acres will be created as mitigation at Westlake Park. The loss of 1.19 acres of mangrove wetlands will be offset by creation of the mangrove wetlands at Westlake Park. Therefore, all impacts with this project will be mitigated and no cumulative impacts are expected.

h. Determination of Secondary Effects on the Aquatic Ecosystem. Secondary impacts on the aquatic ecosystem are not expected.

III. Findings of Compliance or Non-Compliance With the Restrictions on Discharge

a. Adaptation of the Section 404 (b)(l) Guidelines to this Evaluation: No significant adaptations of the guidelines were made relative to this evaluation.

b. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Site Which Would Have Less Adverse Impact on the Aquatic Ecosystem : No practicable alternative exists which meets the study objectives that does not involve discharge of fill into waters of the United States. Further, no less environmentally damaging practical alternatives to the proposed actions exist. The no action alternative would result in the continued safety and operational restrictions to occur at the Port.

c. Compliance with Applicable State Water Quality Standards: After consideration of disposal site dilution and dispersion, the discharge of fill materials will not cause or contribute to, violations of any applicable State water quality standards for Class III waters. The District Commander may seek exemption under 404(r) once the Section 404(b)(1) compliance is met and if we are unable to obtain the water quality certification at the time of submittal of the draft feasibility report to higher authority.

d. Compliance with Applicable Toxic Effluent Standard or Prohibition Under Section 307 Of the Clean Water Act: The discharge operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

e. Compliance with Endangered Species Act of 1973: The disposal of fill material for creation of the artificial reef for project mitigation will not jeopardize the continued existence of any species listed as threatened or endangered or result in the likelihood of destruction or adverse modification of any critical habitat as specified by the Endangered Species Act of 1973, as amended.

f. Compliance with Specified Protection Measures for Marine Sanctuaries Designated by the Marine Protection. Research, and Sanctuaries Act of 1972: No marine sanctuaries are located within the project area.

g. Evaluation of Extent of Degradation of the Waters of the United States: The placement of fill material and dredging of material within the project footprint will result in unavoidable adverse effects on hardbottom, seagrass, and mangrove wetland habitats as well as essential fish habitat. These effects will be mitigated for by construction of mangrove and seagrass habitat at West Lake Park and artificial reef habitat near the harbor. Beneficial effects would occur due to increased biotic diversity and lead to an increase in recreational activities within the artificial reef site. The life stages of aquatic species and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values will not occur.

h. Appropriate and Practicable Steps Taken to Minimize Potential Adverse Impacts of the Discharge on the Aquatic Ecosystem: Appropriate steps have been taken to minimize the adverse environmental impact of the proposed action. The material proposed for artificial reef creation has low silt content, therefore, turbidity due to silt will be low during placement. Turbidity will be monitored so that if levels exceed State water quality standards of 29 NTU's above background, the contractor will be required to cease work until conditions retum to normal. Measures would be taken to minimize sediment deposition on sensitive reef organisms.

On the basis of the guidelines, the proposed dredging and disposal sites are specified as complying with the requirements of these guidelines.

EIS
SUB-APPENDIX C

COASTAL ZONE MANAGEMENT ACT (CZMA) DETERMINATION

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

APPENDIX C
PORT EVERGLADES HARBOR IMPROVEMENT AND MAINTENANCE DREDGING
FLORIDA COASTAL ZONE CONSISTENCY PROGRAM
FEDERAL CONSISTENCY EVALUATION PROCEDURE

1. Chapter 161, Beach and Shore Preservation. The intent of the coastal construction permit program established by this chapter is to regulate construction projects located seaward of the line of mean high water and which might have an effect on natural shoreline processes.

Consistency Statement: The purpose of the proposed action is to improve and maintain safe navigation depths in Port Everglades Harbor, Broward County, Florida. Information will be submitted to the State for a permit in compliance with this chapter.

2. Chapters 186 and 187, State and Regional Planning. These chapters establish the State Comprehensive Plan, which sets goals that articulate a strategic vision of the State's future. It's purpose is to define in a broad sense, goals, and policies that provide decision-makers directions for the future and provide long-range guidance for an orderly social, economic and physical growth.

Consistency Statement: The work has been coordinated with the State without objection.

3. Chapter 252, Disaster Preparation, Response and Mitigation. This chapter creates a state emergency management agency, with the authority to provide for the common defense; to protect the public peace, health and safety; and to preserve the lives and property of the people of Florida.

Consistency Statement: This chapter does not apply.

4. Chapter 253, State Lands. This chapter governs the management of submerged state lands and resources within state lands. This includes archeological and historical resources; water resources; fish and wildlife resources; beaches and dunes; submerged grass beds and other benthic communities; swamps, marshes and other wetlands; mineral resources; unique natural features; submerged lands; spoil islands; and artificial reefs.

Consistency Statement: The proposed activity will be coordinated with the State and appropriate State permits will be obtained. The proposed action will be consistent with the intent of this chapter.

5. Chapters 253, 259, 260, and 375, Land Acquisition. This chapter authorizes the state to acquire land to protect environmentally sensitive areas.

Consistency Statement: As the property is already in public ownership, these chapters do not apply.

6. Chapter 258, State Parks and Aquatic Preserves. This chapter authorizes the state to manage state parks and preserves. Consistency with this statute would include consideration of projects that would directly or indirectly adversely impact park property, natural resources, park programs, management or operations.

Consistency Statement: The proposed action will remove 1.19 acres of mangrove habitat and 0.9 acres of uplands within John Lloyd SRA. These losses will be mitigated.

7. Chapter 267, Historic Preservation. This chapter establishes the procedures for implementing the Florida Historic Resources Act responsibilities.

Consistency Statement: The proposed action was coordinated with the State Historic Preservation Officer (SHPO) and is consistent with the intent of this chapter.

8. Chapter 288, Economic Development and Tourism. This chapter directs the state to provide guidance and promotion of beneficial development through encouraging economic diversification and promoting tourism.

Consistency Statement: The proposed improvements and maintenance therof is consistent with the goals of this chapter.

9. Chapters 334 and 339, Public Transportation. This chapter authorizes the planning and development of a safe balanced and efficient transportation system.

Consistency Statement: The proposed action will not adversely affect public transportation.

10. Chapter 373, Water Resources. This chapter provides the authority to regulate the withdrawal, diversion, storage, and consumption of water.

Consistency Statement: This work does not involve water resources as described in this chapter.

11. Chapter 376, Pollutant Spill Prevention and Control. This chapter regulates the transfer, storage, and transportation of pollutants and the cleanup of pollutant discharges.

Consistency Statement: This work does not involve the transportation or discharge of pollutants. Conditions will be placed in the contract to handle inadvertent spills of pollutants such as vehicle fuels. The proposed action will comply with this chapter.

12. Chapter 377, Oil and Gas Exploration and Production. This chapter authorizes the regulation of all phases of exploration, drilling, and production of oil, gas, and other petroleum products.

Consistency Statement: The proposed action does not involve the exploration, drilling or production of oil, gas or other petroleum products; therefore this chapter does not apply.

13. Chapter 379, F.S., Fish and Wildlife Conservation. The framework for the management and protection of the state of Florida's wide diversity of fish and wildlife resources are established in this statute. It is the policy of the state to conserve and wisely manage these resources. Particular attention is given to those species defined as being endangered or threatened. This includes the acquisition or management of lands important to the conservation of fish and wildlife. This statute contains specific provisions for the conservation and management of marine fisheries resources. These conservation and management measures permit reasonable means and quantities of annual harvest, consistent with maximum practicable sustainable stock abundance, as well as ensure the proper quality control of marine resources that enter commerce.

Additionally, this statute supports and promotes hunting, fishing and the taking of game opportunities in the State. Hunting, fishing, and the taking of game are considered an important part in the state's economy and in the conservation, preservation, and management of the state's natural areas and resources.

Consistency Statement: Marine crustacean, shell and andromous fishery resources will be temporarily impacted. Temporary and permanent impacts will occur within the marine and estuarine environment. Impacts to significant benthic invertebrate resources (e.g species found in coral and hardbottom habitats) will be mitigated. The work in the port will be consistent with the goals of this chapter.

14. Chapter 380, Environmental Land and Water Management. This chapter establishes criteria and procedures to assure that local land development decisions consider the regional impact nature of proposed large-scale development.

Consistency Statement: The proposed action is consistent with the intent of this chapter.

15. Chapter 388, Arthropod Control. This chapter provides for a comprehensive approach for abatement or suppression of mosquitoes and other pest arthropods within the state.

Consistency Statement: The proposed action will be consistent with the goals of this chapter.

16. Chapter 403, Environmental Control. This chapter authorizes the regulation of pollution of the air and waters of the state by the Florida Department of Environmental Regulation (now a part of the Florida Department of Environmental Protection).

Consistency Statement: Appropriate State permits will be obtained for this project.

17. Chapter 582, Soil and Water Conservation. This chapter establishes policy for the conservation of the state soil and water through the Department of Agriculture. Land use policies will be evaluated in terms of their tendency to cause or contribute to soil erosion or to conserve, develop, and utilize soil and water resources both onsite or in adjoining properties affected by the project. Particular attention will be given to projects on or near agricultural lands.

Consistency Statement: The proposed action is not located near agricultural lands; therefore, this chapter does not apply.

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

Planning and Policy Division
Environmental Branch

MAR 2 1 2014

Jeff Littlejohn, P.E.
Deputy Secretary for Regulatory Programs
Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Dear Mr. Littlejohn

Thank you for providing a draft copy of the State of Florida's Coastal Zone Management review letter dated October 1, 2013 regarding the Port Everglades Harbor Modification Project for the Corps to review and respond to. We greatly appreciate your collaborative approach and the opportunity to provide additional information and clarifications addressing the Department of Environmental Protection's concerns.

Attached please find detailed responses to the questions/comments contained in your draft letter. Please contact me at 904-232-1517, e-mail Eric.L.Bush@usace.army.mil or project biologist Ms. Terri Jordan-Sellers, telephone 904-232-1817, e-mail Terri.Jordan-Sellers@usace.army.mil if you have questions or would like to discuss these issues further.

Sincerely,

Eric L Bush
Chief, Planning and Policy Division

Enclosure

Port Everglades Harbor Modification Project
Coastal Zone Management Review
Questions/Comments and Responses

1. **Structural Analysis** – Structural activities including relocation of the U.S. Coast Guard boat basin to accommodate the proposed channel expansion, construction of an "environmentally friendly bulkhead" along the west side of John U Lloyd Beach State Park, construction of a roll-on/roll-off ramp and bulkhead along the west side of the turning notch, and the relocation of the Nova Southeastern University breakwater were mentioned in the draft feasibility report, but are not included in the overall project description, not included in the permit modification application. Please clarify if these structural activities are included as part of the expansion project.

The Corps has withdrawn the permit modification referenced in the draft letter. Replacement of existing rip-rap along the western side of JUL park; as well as along the western shore of the Intracoastal Waterway and along the northern shoreline of the Turning Notch were detailed in Section 2.9.5 of the EIS and are included in the project description. Relocation of the US Coast Guard Basin is included in the description of the Tentatively Selected Plan (TSP) included on Page 2 of the Feasibility Study; as well as Sections 4.6.2 (page 79) and 7.0 (page 121) and in the Engineering Appendix A and B that was included on the DVD sent with each copy of the Report and EIS. Additionally, Section 4.15 of the EIS provides information concerning the project's effects on the Coast Guard Station.

2. **Sediment Data** (inside port harbor) – The report does not include an analysis of sediments inside the port harbor. This information will be used to determine the likelihood that the sediments may contain containments that will warrant the need for additional chemical and biological analysis. Please provide information on the sediment quality of the material to be dredged.

Sections 2.2.12 and 4.6.2 of the Feasibility Study, Section 3.7 of the Engineering Appendix and Sections 3.4, 3.10, 4.8 and Appendix J of the EIS all provide information concerning sediment analysis and the potential for containments to be present. Specifically, Section 3.10 of the DEIS provides a summary of the results of the Tier 1 analysis conducted for the project, the entire Tier 1 is located in Appendix J.

Additionally, as part of the Operations and Maintenance dredging that was completed in the Port between Jan-April 2013, the Corps was required by regulation to test the material to be dredged under the EPA "Green Book" - this testing included physical and biological testing of the material to be dredged to ensure that it met the criteria for disposal in the ODMDS. There was significant overlap in the areas of the 2013 project and the expansion project. The expansion project will also undergo this same level of testing in the PED phase of the project. Additionally, three previous dredging events underwent the same required testing, and all material tested passed the EPA requirements under the ocean disposal criteria in 40 CFR §227.6(c)(3) and §227.27(b):

- A Tier III evaluation of the MTB and NTB was conducted in 1998.
- A Tier III evaluation of the MTB and NTB was conducted in 2004 and a MPRSA Section 103 concurrence was provided for the Port Everglades Harbor in 2005.

In summary - The liquid phase (elutriate) of the material was evaluated for compliance with Sections 227.6(c)(1) and 227.27(a) and analyzed for the contaminants of concern (COC) in marine waters. The concentration of COCs was compared to the EPA National Recommended Water Quality Criteria (WQC) Acute Concentration Levels (Criterion Maximum Concentration (CMC)).

---In the Port Everglades elutriate chemistry assays, only one COC (copper) in one sample that exceeded the EPA WQC. It exceeded the WQC by 0.14 ug/L and was shown in the STFATE model to be sufficiently diluted at the disposal site so as not to exceed the WQC post disposal.

The suspended particulate phase of the material was evaluated for compliance with Sections 227.6(c)(2) and 227.27(b). Bioassay testing of the suspended particulate phase of the material was conducted using three appropriate sensitive marine organisms: Americamysis bahia and Menidia beryllina, in a 96 hour acute toxicity assay; and gametes of Mytilus galloprovincialis, in a 48 hour development assay.

---In the Port Everglades suspended particulate phase toxicology assays, one sample was found to have statistically significantly different larval development from the control. Likewise, it was shown in the STFATE model to be sufficiently diluted at the disposal site so as not to exceed the Limiting Permissible Concentration (LPC) post disposal.

Ten-day whole sediment toxicity tests were conducted on project materials using the polychaete, Neanthes arenaceodentata and the amphipod, Ampelisca abdita. All test species are appropriate sensitive benthic marine organisms and as such, are good predictors of adverse effects to benthic marine communities.

-- In the Port Everglades whole sediment toxicology assays, none of the samples showed organism mortality statistically significantly greater than reference nor did they exceed the reference mortality by more than required amount.

Bioaccumulation potential of contaminants in sediments were evaluated through a 28-day solid phase test using representative species Macoma nasuta and Neanthes virens. Tissues were evaluated for target analytes including metals, butyltins, PAHs, and PCBs.

--In the Port Everglades bioaccumulation assays, tissues tested did not exceed the FDA action limits for any compound for either organism. Concentrations in tissues were compared to tissues exposed to harbor sediments from the Port Everglades reference sample locations. Tissue samples with contaminants statistically greater than the reference sample were further evaluated. The magnitude and number of contaminants in these tissues were assessed using Ecological Non-Specific Effects Thresholds, the EPA Region 4 Eastern Florida Background

Concentrations, and other factors to assess LPC compliance. Based on the results of the evaluation, there was no indication that the project sediments will cause significant bioaccumulation or toxicological effects.

The Port Everglades Final EIS has been updated to include this information in its analysis.

3. **Hyrdodynamic Model** – The RMA-2 Hydrodynamic Model of Port Everglades was not calibrated to field-measures parameters such as velocities, flows and heads. However, reasonable assurance is required to show that the project will not cause violations of water quality standards based on circulation –patterns and flushing characteristics of the project site and surrounding waters. Therefore, a hydrodynamic model that has been calibrated to field-measures parameters will need to be provided.

Unlike riverine ports/waterways (Jacksonville, Savannah, Sabine Neches, etc...), ports that lie directly on the coast, and are directly exposed to the open ocean, are not susceptible to significant environmental changes due to deepening and/or widening on the scale that is seen in the Port Everglades TSP. RMA-2 modeling was conducted in a way which showed the relative differences between with and without project conditions. This type of application is a "first look" to determine if detailed, field calibrated modeling is required. At Port Everglades, the initial RMA-2 modeling reaffirmed that there would be no appreciable change in conditions due to the deepening and/or widening of Federal channels. This is not unexpected as (1) Port Everglades has direct exposure to the open ocean and (2) any other inflow comes from upland canals and is seasonally variable, depending entirely on unpredictable conditions such as drought and storm frequency/intensity. Had the relative modeling effort indicated a significant change in conditions, a detailed modeling effort would have been initiated.

4. **Flooding and Flushing Model** – Deepening the entrance channel, which essentially would increase the cross-sectional flow area, could affect the tidal hydraulics within the confined interior tidal body at a distance from the entrance channel. Should the propagation of the tide through the inlet have the properties of a shallow water wave the tide range should not be reduced. The celerity of the tide wave would increase where deepened and the timing of the peak current and slack tide would occur earlier away from the entrance channel. Reasonable assurance is required to show that the project will not cause flooding of properties within the confined interior water body. Therefore, provide a flooding model and analysis to evaluate potential inland flooding impacts associated with deepening the channel. On the ebb tide, water is advected seaward through the entrance channel that contains higher concentrations of nutrients and other containments compared to levels in open coast waters. Enlargement of the channel brings the possibility of increasing the flux of these substances out of the inlet and into the coastal waters. Furthermore, the vertical velocity and density structures of tidal flows may be stratified and dependent on the tidal phase. The RMA-2 id a depth averaged mode not intended to resolve the vertical features of the channel water column. The field-measurements requested above necessary to validate the applicability of the RMA-2 model as well as calibrate the model.

Flood modeling is not required at Port Everglades due to the location and physical layout of the harbor. Unlike riverine ports/waterways (Jacksonville, Savannah, Sabine Neches, etc...), ports that lie directly on the coast, and are directly exposed to the open ocean, are not susceptible to significant environmental changes due to deepening and/or widening on the scale that is seen in the Port Everglades TSP. This was confirmed at Palm Beach Harbor, where a storm surge evaluation was incorporated into existing CMS modeling of the inlet. Results indicated that channel deepening of the coastal lying port did not appreciably impact storm surge (which is a on a much greater scale than tidal flow). This is further supported by the RMA-2 modeling conducted as part of the Port Everglades study, which indicates a change of flow between with and with-out project conditions of 0.4%. Without a significant change in flow, there cannot be a significant change in surge/flooding. Based on previous experience and coastal physics, flood modeling has not been included as a separate modeling effort for additional projects involving direct access to the open ocean (such as Miami and Port Everglades). While the deepening of the entrance channel will likely alter the rate at which tides/surges enter the harbor (insignificantly at Port Everglades), it will not change the overall volume, level, or extent of the tide/surge. In South Florida, and at Port Everglades in particular, flooding will most likely occur due to upland freshwater releases from Lake Okeechobee and related canals.

In addition to a lack of significant change to the tidal flow, as shown with the RMA-2 modeling, there will not be an increase in the overall amount of nutrients or other contaminants leaving the inlet as the inlet channel, being within yards of the open ocean, experiences a complete flushing during the tidal cycle. Unlike riverine ports, there is not a steady freshwater “stream” passing through the Port and out of the inlet that will be impacted by a change in channel dimension. Inflows into Port everglades are a function of upstream freshwater releases that vary annually and seasonally bring in variable levels of nutrients and contaminants. Deepening will only change the rate at wchih materials are evacuated (insignificantly in the case of Port Everglades), but will not increase or decrease the overall amount (which is a function of upstream variables not controlled by project features) since the proximity of the inlet channels to the open ocean results in complete (rather than partial) flushing. Nutrients and contaminants will flush free of the inlet at a slightly faster rate, but at a slower velocity and over a lesser extent (due to the lower velocities).

5. **Mixing Zone** – What is the size of the requested mixing zone? If a mixing zone is greater than 150 meters in radius is requested, a variance request must be submitted that addresses the elements of § 403.201 F.S. Please identify any natural communities that may be encompassed by the requested mixing zone under § 373.414(1), F.S. The variance request may be approved after practical construction alternatives to avoid and minimize turbidity have been approved.

The permit modification application has been withdrawn and a mixing zone is not being requested as this time.

6. **Hardbottom Impacts** – The Draft EIS does not clearly describe how the hardbottom impacts were determined. The Draft EIS states states that Dial Cordy mapped the area using towed video cameras and benthic assessments; however, no mapping protocols were provided to determine how the mapping was performed. Please provide the estimated acreage of all potential direct and secondary hardbottom impact areas (including the estimated acreage of hardbottom present on the west side slope of the second reef and the east and west side slopes of the third reef) using updated cartographic data (*i.e.*, LADS survey of 2009). Please also provide a formal description of each potential direct and secondary hardbottom impact area with quantitative data on each major functional group (*e.g.*, macroalgae, turf algae, sponges, corals, etc.) and species-indicators (*e.g.*, scleractinian corals, octocorals, etc.), including cover, density, size class distribution, etc., and description of methods used to obtain these data. [§§ 373.414(1) and 403.93345, F.S.]

Project Footprint

The current working project footprint was received from the U.S. Army Corps of Engineers (ACOE) in Oct-2010 and was developed by ACOE Geotechnical and Coastal Engineers to account for appropriate side-slope based on depth and substrate. This footprint has been used to determine current project impact estimates for the 48+1+1+7 NED project as well as incremental impact analysis for 1ft increments of 50-59 feet in Feb-2011 and May-2012 and 55-59 feet in Sept-2013 and Feb-2014.

Hardbottom and Reef

Hardbottom and reef resources are currently based on the "SE FL Benthic Habitats" data modified to include previously unmapped resources per Nova Southeastern University (NSU). This data was provide to the ACOE by NSU on 30-Aug13 and has become the accepted representation of hardbottom and reef resources for the Port Everglades project area.

Vertical Datum

The surface model currently being used to establish the depth of hardbottom and reef resources is the Broward County 2008 LADS (NAVD88) data. The previous surface model was developed from the Broward County 2001 LADS (NGVD29). A vertical datum transformation was performed on the native NAVD88 2008 LADS data in order to have the potential impacts remain in the same vertical datum as previous iterations of impact calculations. The datum transformation was performed using VDatum (v3.2) from NOAA to translate the native NAVD88 to NGVD29.

Detailed data regarding direct and secondary hardbottom impact area with quantitative data on each major functional group (*e.g.*, macroalgae, turf algae, sponges, corals, etc.) and species-indicators (*e.g.*, scleractinian corals, octocorals, etc.), including cover, density, size class distribution, etc., and description of methods used to obtain these data is located in Appendix D-2 of the EIS, "Benthic and Fish Community Assessment At Port Everglades Harbor Entrance Channel" in association with the updated impact assessment provided to FLDEP via two emails to Ms. Danielle Irwin from Terri Jordan-Sellers on February 5, 2014 entitled "Port Everglades – Follow up to this morning's call" with an impact assessment Excel spreadsheet and FW: Port Everglades mitigation interagency briefing" with a PDF file titled

"PortEvergladesAgencyBriefing_4Dec2013-FINAL.pdf" as well as an email dated February 10, 2014 in an email entitled "Re: Port Everglades Mitigation Interagency Briefing" with two Excel Spreadsheets attached.

7. **Mangrove/Seagrass Impacts** – A map depicting the mangrove and seagrass impact areas was provided in the Draft EIS (Figure 71); however, these areas are difficult to view and evaluate because the scale is small. Please provide a graphic representation of the mangrove and seagrass impact areas with a larger scale. Please show the boundaries of the project in relation to the mangrove and seagrass impact areas on the map.

   Please provide a detailed description of each mangrove impact area that accurately characterizes the ecological values of the area and functions provided including: types of mangroves, coverage of each type of mangrove, height, general health of the mangroves, coverage and density of nuisance or invasive exotic plant species, wildlife utilization and type of use, and whether any portion of the assessment area has been used as mitigation for a previously-issued permit.

   Please provide a detailed description of each seagrass impact area that accurately characterizes the ecological values of the area and functions provided including seagrass species, and the coverage and spatial distribution of each species. Please provide the methodology used to characterize the seagrass areas.

   Secondary Impacts – Identify any secondary impact areas where mangroves and seagrass are in close proximity to the project boundaries. If none are expected, provide an explanation as to how the secondary impacts to these communities will be prevented. [§§ 373.414(1) and 403.9328, F.S.]

<u>Seagrass</u>

Seagrass impacts have been estimated using a submerged aquatic vegetation (SAV) survey conducted 27-July thru 3-Aug 2009 that comprised the Inner Entrance Channel (IEC), the Widener (WID), an area extending approximately 1,000 feet north of the Main Turning Basin (MTB), the South Access Channel (SAC), the Dania Cut-off Canal (DCC) and an area extending approximately 1,500 feet south of the DCC. This 2009 survey has been supplemented over the past 4 years with new SAV bed coverage as it has become available in an effort to best represent the extent of SAV during each iteration of impact assessment.

Figure 71 is available as a PDF on the DVD included with the hard copy of the EIS which allows for zooming in on each area. The Corps does not plan to create separate graphics for each seagrass impact area during the Feasibility Phase of the Study. The boundaries of the project in relation to each impact area are included on Figure 71.

An assessment of the ecological functions of the seagrasses in the project was prepared by NMFS (Appendix H of the EIS) and is summarized in Section 3.6.1.2 of the EIS. Detailed data for each of these seagrass areas is provided in Appendix D of the EIS – Specifically the Baseline Report, 2006 seagrass report and 2009 seagrass report. Data includes species composition of each bed, species density, frequency of occurrence and Abundance.

Mangrove

The current estimate of mangrove wetlands was initially developed using a combination of aerial photo interpretation of 1ft resolution natural color photography from USGS (Fall 2005) and ground-truthing by scientists equipped with sub-meter GPS. The extent of mangrove wetlands has continued to updated and refined since the initial layer was developed as new photography and additional data sources have become available.

In addition to the information provided in Sections 3.5.2 and 4.3.2 of the EIS, an assessment of the mangrove areas including the types of mangroves, height, general health or the mangroves, coverage and density of nuisance of invasive exotic plant species was prepared by FLDEP-JUL park staff for this response to comments and USACE defers to the expertise of the park staff regarding these issues:

"1. Types of mangroves: There is a narrow strip of mangroves throughout the impacted area. As such, it is dominated by red mangroves, with a few widely scattered, isolated occurrences of black, white and buttonwood.

2. Coverage of each type of mangrove: Red Mangroves make up over 95% of the mangroves within this 1.15 acre strip of coastline. Black and white mangroves represent about 3%, while buttonwood are at no more than 1% coverage.

3. Height: The heights of these trees vary greatly along the shoreline. There are emergent red mangroves that are less than 2 feet at the edges, with larger specimens of all species farther from the shore and within the areas planted as part of a previous mitigation for port expansion in 1991. These larger trees are from 16 to 30 feet in height.

4. General health: These mangroves represent is a generally healthy natural community. The only impacts to the ecosystem are "minimal" exotic plant species (continually being treated by park staff) and isolated areas of shoreline erosion likely caused by the wave action created by the movement of large vessels within the port channel. There is a large area of erosion that is located directly across from the Dania turnaround cut. The landward edge of this area of erosion is now within approximately 10 feet of the park drive.

5. Coverage: With the exception of access points along the channel that allow staff and visitors to get to the water and the aforementioned points of erosion, the vegetation coverage along the channel is at 100%.

6. Density of nuisance or invasive exotic plant species: As previously indicated in Number 4 above, the exotic plant species within this 1.15 acres is minimal. Park staff have been treating these areas of the park as needed to remove exotics. Estimated coverage of exotics is less than 5%.

Assessment of secondary impacts to mangrove habitats was included in Section 4.3.2 (pages 173 and 174) of the EIS and to seagrass habitats in Section 4.4.1.2 of the EIS (pages 176-177).

8. **Biological Monitoring Plan** – A detailed Biological Monitoring Plan will need to be provided and, if separate, a Sedimentation and Turbidity Monitoring Plan that measures the biological stress at fixed stations within seagrass and hardbottom resource areas adjacent to the proposed work sites that may experience significant amounts of impact due to turbidity, sedimentation, sloughing or direct physical effects (e.g., anchor or spud placement). [§ 373.414(1), F.S.].

A Biological Monitoring plan was included in the Draft EIS as appendix E-5. This plan addresses monitoring for the biological effects of the project at fixed stations on hardbottom resources adjacent to the proposed work sites due to sedimentation, channelside sloughing or direct physical effects. There are no indirect effects to seagrass beds expected to occur per Section 4.4.1.2 of the DEIS.

9. **Minimization of Impacts to Hardbottom and Coral Reef** – DWRM acknowledges that scleractinian corals greater than 10cm in height or diameter will be transplanted prior to dredging to minimize direct effects. Corals of a size class 10 cm to 25 cm are the major reproduction pool, as they have achieved a stage of puberty, and they are two orders of magnitude greater in number than corals of a class >25 cm, and an order of more diversity (number of species). To minimize the direct impacts to the greatest extent practicable, DWRM staff recommends that, in addition to transplanting all scleractinian corals greater than 10 cm in height or diameter, at least 2,000 octocorals greater than 15 cm in eight at least 300 sponges (*Xestospongia muta, Geodia neptuni, Sphesiospngia vesparium* and *Ircina strobilina*), which includes at least 200 sponges greater than 25 cm in diameter and at least 100 sponges greater than 40 cm in diameter, be transplanted as well [§§ 373.414(1) and 403.93345, F.S.].

Based on a review of the artificial reef at Miami Harbor built in 1997 and first surveyed in 2004 (7 years after bare rock was placed at the site), the transplantation of octocorals from the project is not proposed at this time. The artificial reef at Miami had extensive coverage of octocorals in a short period of time, which demonstrates these species are able to quickly colonize an area. The Corps has reviewed the baseline hardbottom report (Appendix D of the EIS) and three of the fours species of sponges referenced in your letter are present, however "The density of barrel sponges was highly variable because of the relatively low number of individuals found."

Based on this statement and data from the baseline report, the Corps cannot commit to relocating a specific number of barrel sponges of the three species found in the project area referenced in your comment. We can commit to collecting additional information during the PED phase of the project and coordinate in the future regarding potentially relocating some of the barrel sponges either to the five-acre artificial reef discussed in the mitigation plan, or to adjacent natural areas.

10. **Mitigation-** The Draft EIS described two potential mitigation options to offset direct impacts to hardbottom. One mitigation option (preferred by the USACE) involves creation of an artificial reef. The other mitigation option (preferred by the National Marine Fisheries Service) involves coral propagation. Please provide a mitigation plan that offsets direct impacts to hardbottom as well as secondary impacts due to turbidity and sedimentation.

    The mitigation plan needs to include functional offsets based on the Uniform Mitigation Assessment Method (UMAM) for both direct and secondary impacts. Although UMAM will be conducted by the Department, the correct estimates of direct and secondary hardbottom impacts must be provided beforehand.

    Degradation to natural communities adjacent to the project area is likely, due to turbidity and sedimentation. The DWRM recommends that the USACE consider upfront mitigation for degradation of a defined area adjacent to the excavation areas. Such a strategy would avoid any additional mitigation associated with time lag related to the post-construction monitoring period, and possibly avoid the additional costs of remobilization to create additional mitigation in the future.

    The Draft EIS states that one mangrove functional unit will be created at West Lake Park to offset 1.16 acres of mangrove impacts, and three seagrass functional units will be created at West Lake Park to offset 4.01 acres of seagrass impacts. Please indicate how the amount of functional units was determined through the UMAM. Also indicate how many acres of mitigation will be provided by one mangrove functional unit and three seagrass functional units. Please provide a letter from either the South Florida Water Management District or Broward County authorizing the proposed mitigation at West Lake Park, and a statement that the proposed mitigation is consistent with the overall mitigation plan for West Lake Park. Please provide a detailed mitigation plan for both mangrove and seagrass impacts including maintenance, monitoring and construction sequence and techniques. Staff requires this information to conduct UMAM for each type of impact.[§§ 373.414(1), 403.9328 and 403.93345, F.S.]

A joint mitigation plan, developed by USACE and NMFS is attached to this correspondence. This mitigation plan is undergoing final internal technical and policy review. The Corps has included upfront mitigation for a total of 2% loss of function of hardbottom habitats within 150m of the entire project footprint. Additional mitigation beyond this 2% would be based on pre- and post-construction monitoring. The number of available credits in West Lake Park was determined by the South Florida Water Management District during their permitting process. FLDEP staff should coordinate with your counterparts in SFWMD to determine the details of how those UMAM assessments were conducted. The maintenance, monitoring and construction of the West Lake Park project is being conducted solely by Broward County parks vision per the requirements of their permits. The permits include requirements for monitoring, maintenance and construction. Both the SWFWD and the USACE-RD permit were included in the EIS in Appendix E of the DEIS.

11. **John U. Lloyd Beach State Park Impacts:**

Bulkhead Design – With regard to the park marina entrance/exit, there are no details of how the "environmentally friendly bulkhead" will be designed or configured to accommodate the visitor boat access to the park marina. Will the bulkhead design restrict boaters from utilizing the existing marina? Please provide additional information on bulkhead design and the maximum boat draft that will be able to pass over the bulkhead. Due to increased demand for recreational boating, an expansion of the marina on the north side of Whiskey Creek is also planned. Also consider and document the potential impacts of the bulkhead to the submerged fauna, flora, and natural processes of the area.

Just north of Whiskey Creek is a "U"-shaped canal that was created as a manatee sanctuary as mitigation for previous port upgrades. Please provide assurances that the proposed bulkhead will not impede the hydrologic functions of the sanctuary or the use of the area by manatee and kayaking park visitors.

The preferred alternative indicates that the submerged bulkhead would be installed on the east side of the channel. Based on the maps provided, the bulkhead appears to be recommended in a location that would cut across the park's office/shop area. The proposed location would be quite close to several park staff residences and the ground solar array in that same area. If the bulkhead cannot be redesigned to avoid disturbance to these facilities, appropriate mitigation, including relocation of displaced facilities, should be provided.

On Figure A-78 in Appendix A-Engineering, the height ofthe toe wall is shown as 34 feet (-31.0 to -65.0 MLLW) with a penetration of 10 feet below the improved grade. Please provide the basis for the toe wall design (tip elevation of -65.0 MLLW).

Natural Resources – According to GIS maps provided by the USACE, the expansion of Port Everglades will directly impact approximately 4.45 acres of the park. The natural communities affected by this project include seagrass (0.05 acres), unconsolidated substrate (2.82 acres), mangrove swamp (1.15 acres), and developed (0.43 acres). The mangrove area that would be affected is located along the east shore of the Intracoastal Waterway and was planted as mitigation for a previous Port Everglades project – appropriate compensation must be provided. Every effort should be applied to minimize impacts to the park's natural resources. Additionally, provide a conceptual mitigation plan that would offset the remaining losses.

If blasting is required during the dredging process or for the placement of sheet pile bulkhead, impacts to imperiled species, fragile submerged habitats, park resources and facilities, and the park visitor experience could occur. Please provide information on how these impacts will be avoided or minimized. If these impacts cannot be avoided or minimized, please provide information on mitigating the impacts.

Boat Launch Area- The extension of Berth 27 will result in ships docking closer to the marina exit at John U. Lloyd Beach State Park. During periods such as Fleet Week, the park has been required to close the boat launch area for security purposes. Historically, these closures have been for a period of up to a week, hampering public use of the park. The proposed expansion will allow ships to berth even closer to the mouth of the creek, creating additional security concerns and potential disruptions to public access.

Board of Trustees Authorization – As noted in the Draft EIS, impacts to the state park must meet the Board of Trustees' 1988 POLICY FOR INCOMPATIBLE USE OF NATURAL REsouRCE LANDS. If the parties involved in the proposed disposition of state lands (*i.e.,* Board of Trustees, Division of Recreation and Parks, Broward County, and USACE) agree that Broward County should obtain fee-simple titled ownership of the affected bulkhead area, the County would apply to the Department's Division of State Lands to have the area designated as surplus and sold/deeded to Broward County.

If it is determined that the Board of Trustees will retain fee-simple ownership, the County would either: apply for a lease from the Board of Trustees for the bulkhead area, apply
for a sublease from the Division of Recreation and Parks, or apply for an easement from the Board of Trustees with the Division of Recreation and Parks' consent.

Any application to use state land which would result in significant adverse impact to state land or associated resources shall not be approved unless the applicant demonstrates there is no other alternative and proposes compensation or mitigation acceptable to the Board of Trustees under § 18-2.018(2)(i), *Florida Administrative Code* (F.A.C.). Any requested use of state land which has been acquired for a specific purpose, such as conservation and recreation lands, shall be consistent with the original specified purpose for acquiring such land in accordance with§ 18-2.018(2)(c), F.A.C. Applicants applying for a lease or easement across state land which is managed for the conservation and protection of natural resources shall be required to provide net positive benefit as defined in§ 18-2.017(38), F.A.C., if the proposed lease or easement is approved. [§§ 253.03, 253.034 and 253.04, F.S.]

The EFB bulkheads will not restrict boaters from utilizing the existing marina. The Feasibility report shows the conceptual locations of the EFBs, indicating where stabilization will be required. During the design phase of the project, care will be taken to ensure that bulkheads will not adversely impact existing public access points, such as marina's and boat ramps.

A key element of the "environmentally friendly bulkhead" is to minimize adverse impacts to the greatest extent possible. In addition to being submerged with a permeable riprap cap to maintain current levels of flushing to local mangroves, placement of the bulkheads will be such that no existing access points to sanctuaries or conservation areas will be obstructed. The potential also exists, during the design phase, to incorporate further design features to enhance/improve existing conditions for local flora/fauna adjacent to impacted channels.

While it is not possible to alter the location of the SAC EFBs, due to requirements of the S-class design vessel, any disturbance to facilities will be mitigated for. The location of the EFB's, as of 2011 site surveys, were not in conflict with any existing structures or facilities. However, additional site surveys will be made prior to final design. If any conflicts are identified proper mitigation, including reimbursement/relocation with be included.

Figure A-78 is a conceptual bulkhead cross-section suitable for Feasibility level planning and costs. This design was developed based on currently available geotechnical information and maximum possible project depths. A more detailed design, with supporting documentation, will be produced during the PED (design) phase of the project. Design will be based on updated, detailed geotechnical analyses and will be adjusted as necessary to accommodate site specific conditions throughout the project area.

With regard to the mangrove impacts, every effort to date has been made to reduce and avoid these impacts to the maximum extent practicable through design and ship simulation as detailed in Section 2.5.5 of the EIS. Any remaining mangrove impacts are to be mitigated for as part of the West Lake Park restoration project already permitted and in construction. Permits for that plan were included in Appendix E of the EIS.

As detailed in Section 2.9.3.2 the EIS, confined blasting as a rock pre-treatment technique is assumed to be requires for Port Everglades based on the available geotechnical information and previous history of dredging in the port. Protective measures for protected species is included in the EIS and detailed in Section 2.9.3.2.3 and for structures in Section 2.9.3.2.4. Impacts to park visitors should be minimal as the maximum number of blasts per day is two; each lasting for less than 5 seconds each. Measures to ensure public awareness of blasting as a pre-treatment technique includes Notice to Mariners and public workshops prior to blasting operations beginning. The Park's staff will be on the list of agencies and individuals to coordinate with during the preparation and operations phases of blasting activities.

Lastly, the Corps has no role in operations at the Port during Fleet Week, and recommends that the Park coordinate directly with the Port and the security staff for issues regarding closures of park boat ramps during those periods in time.

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

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SECRETARY

June 13, 2014

Mr. Eric P. Summa, Chief
Environmental Branch, Jacksonville District
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, FL 32232-0019

RE: Department of the Army, Jacksonville District Corps of Engineers
Draft Feasibility Report and Environmental Impact Statement, Navigation Study for Port Everglades Harbor – Fort Lauderdale, Broward County, Florida.
SAI # FL201306266640C

Dear Mr. Summa:

The Florida State Clearinghouse has coordinated the state's review of the referenced U.S. Army Corps of Engineers' (USACE) June 2013 Draft Feasibility Report and Environmental Impact Statement (EIS), March 2014 supplemental mitigation information, and subsequent communication and presentations both by the USACE and the National Marine Fisheries Service (NMFS) under the following authorities: Presidential Executive Order 12372; Section 403.061(42), *Florida Statutes* (F.S.); the Coastal Zone Management Act (16 U.S.C. §§ 1451 *et seq.*, as amended); and the National Environmental Policy Act (42 U.S.C. §§ 4321-4347, as amended).

Based on the findings of the Florida Department of Environmental Protection (Department), and the provisions of 15 C.F.R. 930, Subpart C, the Department hereby notifies the USACE that the proposed federal action is conditionally consistent with the enforceable policies of the Florida Coastal Management Program (FCMP) provided the conditions listed below are satisfied.

The feasibility studies provided as part of the Draft EIS review represent approximately 30% design effort, and staff believes that more detail is needed for the state to meet its water quality certification obligations under the Clean Water Act and Florida Statutes, which will also be subject to federal consistency requirements as a separate federal action than this review of the Draft EIS. Based upon the in-depth review of the proposed impacts and updated mitigation plan by our federal partners at the NMFS, we are confident the USACE will be able to provide the necessary documentation during the permitting phase of the project, however, should that not occur, this *conditional concurrence* will be treated per the provisions of 15 C.F.R. § 930.4(b) as a finding that this proposed federal action is inconsistent with enforceable policies of the FCMP, specifically §§ 373.414(1), 161.041(4), 253.03, 253.034 and 253.04, F.S.

The state's concurrence with the determination of consistency is conditioned on the USACE's providing the following items for further review, which must support the Department finding that reasonable assurance has been provided that state water quality standards will not be violated (§ 373.414(1), F.S.), the activity is not contrary to the public interest (§ 373.414(1), F.S.), adequate mitigation and biological monitoring are provided (§ 161.041(4), F.S.), and the use of sovereignty submerged lands and state-owned natural resource lands will meet the requirements for authorization by the Board of Trustees of the Internal Improvement Trust Fund (§§ 253.03, 253.034 and 253.04, F.S.):

1. **Flooding and Flushing Model** – Demonstration that the project will not cause flooding of properties within the confined interior water body. [§ 373.414(1), F.S.]

2. **Hardbottom Impacts** – Data in sufficient detail to perform a Uniform Mitigation Assessment Method (UMAM) analysis. [§ 373.414(1), F.S.]

3. **Mangrove/Seagrass Impacts** – Identification of any potential secondary impact areas where mangroves and seagrasses are in close proximity to the project boundaries. [§ 373.414(1), F.S.]

4. **Monitoring and Mitigation Plans** – Mitigation plans that quantify and adequately offset both the direct and secondary impacts from construction and resulting sedimentation and within seagrass, hardbottom and mangrove resource areas adjacent to the proposed work sites. [§§ 373.414(1) and 161.041(4), F.S.]

5. **John U. Lloyd Beach State Park Impacts** – Details on avoidance and minimization, offset any impacts to the park and necessary authorization to use state lands. [§§ 253.03, 253.034 and 253.04, F.S.]

The Department looks forward to continued coordination with USACE staff to resolve the foregoing issues and offers its assistance in amending the proposal to ensure consistency with Chapters 161, 253 and 373, F.S. We are committed to continued collaboration with the Jacksonville District on understanding the effects of the proposed project on the state's resources. The Department is hopeful that the effects can be appropriately and adequately mitigated and monitored. As the Jacksonville District moves forward into design and eventual permit application for water quality certification with the state, the issues outlined above will need to be further addressed in construction level detail by our respective staffs.

In accordance with 15 C.F.R. § 930.4, if the federal action is not altered in accordance with the conditions stated above, this conditional concurrence shall be treated by all parties as an objection. The USACE shall not proceed with the objectionable portion of the proposed project unless: it has concluded that consistency with the enforceable policies of the FCMP is prohibited by existing federal law applicable to USACE, in which case, the USACE must clearly describe, in writing to the Department, the legal impediments to full consistency; or the USACE concludes its proposal is fully consistent with the enforceable policies of the FCMP despite this objection.

Pursuant to 15 C.F.R. § 930.43, a federal agency deciding to proceed with an activity over a state's objection or to follow an alternative suggested by the state must notify the state of its decision prior to commencement. In accordance with 15 C.F.R. § 930.43(e), a copy of this letter has been sent to the Director of the NOAA Office of Ocean and Coastal Resource Management. Mediation by the Secretary of the U.S. Department of Commerce may be sought pursuant to 15 C.F.R. 930, Subpart G, for serious disagreements between a state and federal agency with regard to direct federal action as contemplated by 15 C.F.R. 930, Subpart C.

Thank you for the opportunity to review the Draft EIS and subsequent submittals. For additional information, please contact Ms. Lauren Milligan, Coordinator of the Florida State Clearinghouse, at Lauren.Milligan@dep.state.fl.us, (850) 245-2170, or Ms. Kelly Samek, Administrator of the Florida Coastal Management Program, at Kelly.Samek@dep.state.fl.us, (850) 245-2177.

Sincerely,

Mark Thomasson, P.E.
Director, Division of Water Resource Management

Enclosures

cc: Mr. Paul Scholz, NOAA OCRM Acting Director
Ms. Terri Jordan-Sellers, USACE-SAJ
Mr. Steven Cernak, Broward County Port Everglades Department
Ms. Danielle Irwin, DEP Division of Water Resource Management
Dr. Lainie Edwards, DEP Beaches, Mining and ERP Support Program
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Mr. Kevin Claridge, DEP Florida Coastal Office
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Ms. Joanna Walczak, DEP Florida Coastal Office
Mr. Parks Small, DEP Bureau of Natural and Cultural Resources
Mr. Lewis Scruggs, DEP Office of Park Planning
Mr. Paul Rice, DEP Bureau of Parks District 5
Ms. Lauren Milligan, DEP Office of Intergovernmental Programs
Mr. Scott Sanders, FWC Conservation Planning Services

August 7, 2013

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DEP Office of
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Ms. Lauren Milligan
Office of Intergovernmental Programs
Florida Department of Environmental Protection
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Lauren.Milligan@dep.state.fl.us

RE: SAI #FL201306266640C – Department of the Army, Jacksonville District Corps of Engineers – Draft Feasibility Report and Environmental Impact Statement, Navigation Study for Port Everglades Harbor – Fort Lauderdale, Broward County, Florida

Dear Ms. Milligan:

Florida Fish and Wildlife Conservation Commission (FWC) staffs have reviewed the Draft Feasibility Study (DFS) and Environmental Impact Statement (DEIS) for Navigation Improvements in Port Everglades Harbor. The FWC is providing comments and recommendations pursuant to the National Environmental Policy Act and the Coastal Zone Management Act Florida Coastal Management Program.

In 2001, the United States Army Corps of Engineers (USACE) initiated a Feasibility Study for navigation improvements to Port Everglades in coordination with a non-federal sponsor, Broward County Department of Port Everglades. Since 2001, there have been two interim DEIS' (in 2008 and 2011) that have been provided to the FWC for review and comment. The current document submitted to the State of Florida for review is a complete DFS and DEIS. The navigation improvements proposed in the DFS/DEIS are as follows:

- Deepen the Outer Entrance Channel (OEC) to an authorized depth of 48 feet (i.e., -48 feet Mean Low Low Water; actual depth of 57 feet);
- Widen the OEC to 800 feet on the seaward end, and extend it 2,200 feet seaward;
- Deepen the Inner Entrance Channel (IEC) to 48 feet (50-foot actual);
- Deepen the Main Turning Basin (MTB) to 48 feet (50-foot actual).
- Widen the rectangular shoal region to the southeast of the MTB by about 300 feet and deepen to 48 feet (50-foot actual);
- Widen the Southport Access Channel (SAC) in the proximity of berths 23 to 26 by about 250 feet and relocate the USCG facility to the east;
- Shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition back to the existing federal channel limits;
- Deepen the SAC from about berth 23 to the south end of berth 32 to 48 feet (50-foot actual);
- Deepen the Turning Notch (TN) to 48 feet (50-foot actual) with an additional 100-foot north-south widening parallel to the SAC on the eastern edge of the SAC over a length of about 1,845 feet, and

- Widen the western edge of the SAC for access to the TN from the existing federal channel edge near the south end of berth 29 to a width of about 130 feet at the north edge of the TN.

We do not find this project inconsistent with our authorities under Chapter 379, Florida Statutes. We would, however, like to provide the USACE information regarding fish and wildlife resources ahead of finalization of the DFS DIES. Our comments and recommendations in this regard are enclosed.

The FWC appreciates the opportunity to review the DFS/DEIS for Navigation Improvements in Port Everglades Harbor and remains committed to assisting the expansion of this port with minimal impacts to the state's fish and wildlife resources. Should you require additional assistance regarding our comments, please contact Jane Chabre at (850) 410-5367 or by email at FWCConservationPlanningServices@MyFWC.com.

Sincerely,

Scott Sanders, Director
Office of Conservation Planning Services

ss/jdg/lg
ENV 1-3-2
Port Everglades Harbor Draft Feasibility Report and EIS 17763 080713
Enclosure

FWC Comments
Port Everglades Harbor
Draft Feasibility Report (DFR) and Environmental Impact Statement (DEIS)

DEIS Statement, pages ii and v; Section 4.4.1.2 Alternative 2E (TSP), page 176
The DEIS identifies that 4.01 acres of seagrass will sustain direct impacts. This acreage was derived from the 2009 Dial Cordy and Associates (DC&A 2009b) seagrass survey, which did not include a survey of the Outer Entrance Channel. Seagrass surveys performed prior to and including the DC&A 2009b survey establish that seagrass growth fluctuates and the overall area viable for seagrass growth is greater than the 4.01 acres identified in the DEIS. As supported by DEIS Section 3.6.1.2 "Seagrass Species Biology and Ecology" (pages 103-104), seagrass habitats include continuous vegetated beds as well as patchy environments with unvegetated areas between the patches. Distribution and abundance of all seagrass species naturally fluctuate temporally and spatially for a variety of reasons (e.g., changes in water quality, current flow, etc.), especially in patchy seagrass habitats. The absence of seagrass in a particular location during a single survey event does not indicate that the location is not viable seagrass habitat. For this reason, impact assessment should consider the broader seagrass habitat established by multiple surveys and not just the most currently surveyed vegetated portions. Not using this method may result in an inaccurate reflection of actual seagrass impacts and thus an inaccurate mitigation calculation. The FWC recommends that seagrass impact acreage should be adjusted to include the cumulative acreage of all viable seagrass habitat. This cumulative area approach to seagrass impact assessment was previously recommended in FWC Second Interim IDEIS Comments, dated May 31, 2011 (comment #38), and remains the recommended method for accurate impact assessment.

Section 2.7.2 Fish, Wildlife, and Invertebrates, page 46
The DEIS states that as an avoidance and minimization measure, scleractinian corals over 10 cm in diameter or height will be removed from the direct impact area and transplanted directly to the mitigation sites, or to coral nursery areas until the mitigation sites are constructed. The DEIS states that all listed Acroporid coral species within the project footprint will be relocated, as will the 716 corals that are 25 cm and larger within the footprint. However, the DEIS does not address relocation of corals others than those identified above and does not address relocation of octocoral species.

Species listed as Proposed Species under the Endangered Species Act (ESA) are Candidate species that were found to warrant listing as either threatened or endangered. These species were proposed as either endangered or threatened in a *Federal Register* notice after the completion of a status review and consideration of other protective conservation measures. The proposed minimum size of 25 cm for relocation would preclude many viable specimens of ESA Proposed Species, adult colonies (defined as colonies 5 cm in diameter or greater) , and fertile colonies of relatively small species that will not likely reach 25 cm such as *Favia fragum, Siderastrea radians,* and *Porites astreoides* (Soong 1993). Colonies greater than 5 cm are generally considered to be adults (Bak and Engel 1979) (Miller et al. 2000), based on average growth rates (Vaughn 1915) and estimated age of sexual maturity (Connell 1973). Corals greater than or equal to 5 cm in diameter can be successfully relocated. Brownlee (2010) successfully transplanted small coral (*Siderastrea siderea,* *Dichocoenia stokesii*, and *Porites porites*) with greater than 80 percent survivorship after 13 months. Monty et al. (2006) successfully transplanted 250 corals (14 species) ranging from 5 to 40 cm in diameter with a high rate of survivorship. These corals were monitored for 13 months. Eight species had 100 percent survivorship, including 78 *Siderastrea siderea*. Thornton et al. (2000) transplanted 271 corals from an outfall pipe in Broward County to an articulated concrete mat. *Siderastrea siderea* comprised 90 percent of the corals <1 to 100 cm^2 in size. After 27 months, 266 of the corals had survived (87 percent), as compared to 83 percent survival for corals on the nearby natural substrate. In addition, Stephens (2007) salvaged from a coastal construction impact site in Broward County and 92 to 100% of the transplants survived after 18 to 24 months. As such, the FWC recommends relocation of all ESA Listed and Proposed Species regardless of size, and adult corals (those 5 cm or greater) within the footprint. In the event that all corals 5 cm in size or greater will not be relocated, we have provided a prioritized list of coral species for relocation. These coral species were prioritized based on a high conservation value (i.e., listing status, rare, slow-growing, slow to recover, sensitive to stress, poor-recruiter, high post-settlement mortality), and are as follows:

1) *Acropora cervicornis* and *A. palmata* (ESA listed as Threatened; Proposed Endangered species)
2) *Dendrogyra cylindrus* (ESA Proposed Endangered species)
3) *Montastrea annularis* (ESA Proposed Endangered species)
4) *Montastrea faveolata* (ESA Proposed Endangered species)
5) *Montastrea franksi* (ESA Proposed Endangered species)
6) *Mycetophyllia ferox* (ESA Proposed Endangered species)
7) *Agaricia lamarcki* (ESA Proposed Threatened species)
8) *Dichocoenia stokesii* (ESA Proposed Threatened species)
9) *Montastraea cavernosa*
10) *Colpophyllia natans*
11) *Diploria* spp.
12) *Mycetophyllia* spp.
13) *Agaricia* spp.
14) *Eusmilia fastigiata*
15) *Porites porites*
16) *Meandrina meandrites*
17) *Solenastrea hyades*
18) *Solenastrea bournoni*
19) *Madracis* spp.
20) *Oculina diffusa*
21) *Porites astreoides*

The least amount of effort should be attributed to:

1) *Siderastrea siderea*
2) *Stephanocoenia intersepta*
3) *Siderastrea radians*

The following species are rare, but some individuals (not colonies) may be encountered. We would not recommend expending resources to locate them as we are not sure if they are amenable to relocation:

1) *Scolymia* spp.
2) *Phyllangia* spp.
3) *Cladocora arbuscula*

The FWC also recommends relocation of all *Gorgonia* octocorals within the footprint, and other octocoral species 10 cm in height or greater based on the prioritized list below. These octocoral species were also prioritized based on a high conservation value [i.e., state prohibited species, conservation need, local (SE FL) abundance/density, growth rates, transplant success, and ability to recover naturally]. In general, more robust rod species are slow growing and have low recruitment, but transplant well and seem to recover quickly from being transplanted (e.g., growing a new holdfast over attachment material). Plumes are low on the list because they recruit very quickly after a disturbance and have high growth rates so their potential for natural recovery is greater. Additionally, more delicate plume species have less tissue (thinner tissues = less potential/resources for healing after clipping) and are inferior transplant candidates. However, plumes can be transplanted successfully. The minimum height of 10 cm was determined based on the results presented in the Port Everglades Reef Report (2009). Octocorals of this height and greater are representatives of the octocoral community to be impacted. The FWC can provide underwater identification cards for the prioritized octocoral genera to assist with colony selection. The prioritized list is as follows:

1) *Gorgonia* [state prohibited species as defined under 68B-8.002(20)]
2) *Eunicea*
3) *Plexaurella*
4) *Pseudoplexaura*
5) *Pterogorgia*
6) *Muriceopsis*
7) *Muricea*
8) *Plexaura*
9) *Leptogorgia*
10) *Pseudopterogorgia*

In addition to the species listed above, the following are priority genera if deeper relocation sites are targeted (60'+):

1) *Iciliogorgia*
2) *Eunicella*
3) *Swiftia*

Section 2.9.2.1 Mechanical Dredging and 2.9.2.2 Hydraulic Dredging

1) The Draft Feasibility Report (DFR) and the DEIS states that the USACE will adhere to the 2011 version of the Standard Manatee Construction Conditions along with other manatee protections addressed in the DFR/DEIS. The scope of the project includes

activities that may not be addressed in the standard manatee conditions and have not been addressed in the DFR/DEIS. For this reason, the FWC recommends that the dredging measures outlined for manatees in the USACE Port Everglades maintenance dredging permit 0220509-001-JC and modifications 0220509-005-JN and 0220509-006-JN of that permit also be followed for this project. This includes dredge observer specifications, and manatee considerations in the area defined as an important manatee area, and a smaller, defined area around the power plant discharge area where no clamshell dredging will occur during the wintertime. We also recommend inclusion of additional conservation measures from the Miami Harbor Phase III project (permit 0305721-001-BI); specifically specifications for marine species as an element of the USACE environmental plan, keeping a marine species sighting log and submitting a report, and gravity release of clamshell buckets at the water's surface.

2) The FWC recommends the dredge selected and any equipment used for beach placement of dredged material should be required to clearly specify the types of lights on the equipment, the purpose for the lighting, and appropriate shielding to ensure that sea turtle protections are met during any project activity that occurs between March 1 and October 31. All permanent exterior lighting fixtures associated with the project should utilize long wavelength lighting to the degree possible, avoid full-spectrum light such as metal halide and white LED, be mounted as close to the surface to be illuminated as practicable, be full cutoff, and be shielded. In addition, long-term local agreements should be arranged to ensure appropriate surveys and protective measures are in place to address escarpment, tilling, and lighting compliance requirements after the initial year of construction.

3) As recognized by the USACE, impacts to swimming sea turtles may also occur during project activities. The USACE has indicated that, in the event a hopper dredge is utilized, the Terms and Conditions of the applicable NMFS Regional Biological Opinion for Hopper Dredging would be followed. The following recommendations are provided for further protection and will facilitate FWC's assistance to USACE staff in handling sea turtle injury: Contact Dr. Allen Foley, the Sea Turtle Stranding and Salvage Network (STSSN) Coordinator at Allen.Foley@myfwc.com at the start-up and completion of hopper dredging operation; report any collisions with and/or injury to a sea turtle shall be reported to the STSSN at 1-888-404-FWCC (3922).

In addition, it is not clear from the DEIS as to whether or not relocation trawling or non-capture trawling will be implemented. Any activity involving the use of nets to harass and/or to capture and handle sea turtles in Florida waters requires a Marine Turtle Permit from FWC as well as reporting of all trawling activity.

Section 2.9.3.2 Confined Underwater Blasting

The USACE commits to implement the confined underwater blasting protective measures developed for the Miami Harbor Phase III Federal Channel Expansion project for both construction and test blasting within the Port Everglades project area. The FWC notes that language regarding blasting for the Miami Harbor Phase III (permit 0305721-001-BI) has been revised and improved. We recommend use of the revised language, particularly for protected species observer qualifications, which is a critical part of a successful monitoring plan.

Additionally, the USACE has committed to conducting caged fish studies to help inform development of avoidance and minimization measures for marine fish species for confined blasting activities. There is potential for USACE to conduct such caged fish studies during the Miami Harbor Phase III Expansion project. Information resulting from these Miami Harbor studies or other projects in which the USACE may be using confined underwater blasting would be useful in development of Best Management Practices (BMPs) for Confined Underwater Blasting and Marine Fisheries Resources. BMPs developed as a result of these studies should be incorporated into this project.

Section 2.9.3.2.4 Vibration and Pressure Monitoring
This section includes discussion of potential impacts to commercial properties, utilities and residential communities caused by vibrations from blasting. Because vibrations from blasting have the potential to affect the structural integrity of nearby properties, it is possible that these vibrations may also affect the structural integrity of adjacent hardbottom habitat or sessile organisms attached to hardbottom habitat. A project of this size including the proposed amounts of blasting has not been conducted in Florida, so the potential effects to the structural integrity of surrounding areas and attached species are not known. The FWC requests the current discussion in this section be expanded to identify and address potential impacts from blasting vibrations to the structural integrity of hardbottom habitat and sessile organisms attached to hardbottom habitat adjacent to the project impact area.

Section 2.9.4 Disposal of Removed Materials
The USACE Tentatively Selected Plan (TSP) involves channel dredging and disposal of significant amounts of material that will be generated from dredging. The DFR/DEIS states that material to be dredged is not beach-compatible. However, at the same time as publication of the DFR/DEIS, the USACE had submitted JCP Application No. 0220509-007-JM. This application has since been withdrawn, but the USACE recognizes that beach placement may be used as a disposal method. The beach placement area that is currently approved in the existing maintenance dredge permit (Segment III limits of the Broward County shore protection project) may be suitable once the overburden material located in the entrance channels has been screened. If disposal of material on or near that beach placement area occurs, impacts to nesting and hatchling sea turtles could occur. Therefore, it is important that mechanisms are in place to ensure that only beach-quality material is placed on the beach. Methods for beach and nearshore placement including placement areas, proposed beach profiles, construction and design templates, any pipeline placement, equipment needed, and travel corridors must be designed to minimize impacts to sea turtles, their nests, and nesting habitat. Additionally, beach placement of dredged material may affect nesting shorebirds and seabirds. Standard protection measures for shorebirds and seabirds should be incorporated into the project evaluation and should include measures that:

1. Ensure personnel associated with the project are aware of the potential presence and the need to avoid take of these protected species.

2. Use observers to monitor for beach-nesting bird activity, establish buffer zones and travel corridors, and assist personnel in conducting work in a manner that avoids take.
3. Ensure equipment storage and placement does not result in take.
4. Ensure that any tilling or mechanical beach-raking is conducted in a manner that does not result in take.

Sections 2.9.2 – 2.9.4
These sections discuss material removal, disposal, and rock pre-treatment, but absent from the DEIS is any discussion of reef/seafloor structural repair or rubble stabilization. Repair and stabilization will be necessary post-construction due either to blasting vibrations (see Section 2.9.3.2.4 comments above), or dredging activities. Impacts from dredging have been well documented and it has been shown that deterioration of the reef can continue for several years after the cessation of dredging because of continual resuspension and movement of dredged materials (Rogers 1979). Rubble has also been shown to cause high mortality rates of coral recruits (Edwards and Gomez 2007), and rubble at injury sites has been documented to reduce the numbers of stony coral species, percent cover, density, and largest colony size (Gilliam and Moulding 2012). The 2006 Dial Cordy and Associates (DC&A 2006) report indicated that stabilizing the seafloor following dredging may be one of the most significant measures that could minimize post-construction impacts to surrounding reef communities. The FWC recommends inclusion of another section in the DEIS that discusses actions that will be taken to repair structural damage and stabilize rubble attributed to construction activities. Potential alternatives for rubble stabilization can be found in Edwards and Gomez (2007) and Collier et al. (2007). If structural damage is not repaired and rubble will not be stabilized, the repeated impacts to nearby reefs from unstabilized rubble should be incorporated into impact and compensatory mitigation assessment.

Section 3.6.1.3 Spatial and Temporal Patterns of Study-Area Seagrass Beds, page 105
This section of the DEIS states that the 2001 Dial Cordy and Associates (DC&A 2001) survey documented 1.04 acres of *Halophila decipiens* seagrass in the Outer Entrance Channel. It further states that the presence of this same seagrass bed could not be confirmed by the 2010 Dial Cordy and Associates (DC&A 2010) videographic survey. The DC&A 2010 videographic surveys were conducted for Acroporid corals, and there is no mention of seagrasses in the DC&A 2010 report for these surveys. Even if DC&A were looking for seagrasses during the course of Acroporid coral surveys, the videographic survey methodology that was used in DC&A 2010 for Acroporid corals is not an appropriate survey methodology for seagrasses. Videographic surveys are likely unable to confirm the presence/absence of *Halophila decipiens*, especially due to potentially poor visibility in the Outer Entrance Channel and the patchy distribution of Halophilas. No seagrass surveys have been conducted in the Outer Entrance Channel since DC&A 2001, when the 1.04 acre seagrass bed was originally documented.

This section of the DEIS attributes the presumed absence of the 1.04-acre *Halophila decipiens* seagrass bed in the Outer Entrance Channel (based on the DC&A 2010 Acroporid coral survey) to activities associated with the Broward County Shore Protection Project, in which Broward County dredged the Port Everglades Entrance Channel during November

2005 through February 2006. DEIS Section 3.6.1.2 "Seagrass Species Biology and Ecology" (pages 103-104) provides the more likely explanation for this presumed absence of seagrass in the Outer Entrance Channel by recognizing that distribution and abundance of all seagrass species naturally fluctuate temporally and spatially for a variety of reasons (e.g. changes in water quality, current flow, etc.), especially in patchy seagrass habitats such as Port Everglades.

The FWC maintains that use of the cumulative area approach to seagrass impact assessment as identified in our comments on Section 4.4.1.2 above, would appropriately characterize the seagrass resources in the Outer Entrance Channel and, when done appropriately, would have captured the need to mitigate for the 1.04 acres identified above. With or without using the cumulative area approach, the DC&A 2001 survey stands alone in establishing this 1.04-acre area located in the Outer Entrance Channel as either containing or having the potential to contain a 1.04-acre *Halophila decipiens* seagrass bed. Therefore, this area should be considered as 1.04 acres of viable seagrass habitat. This area was not included in the stated 4.01 acres of seagrass that will be directly impacted by the project, and should be factored in to impact assessment and compensatory mitigation assessment if it is not located within a previously dredged area. Because survey location information was not provided in the DEIS, the FWC requests the USACE provide the coordinates of the DC&A 2001 survey, and supporting documentation that establishes whether or not the survey coordinates fall within a previously dredged area to determine mitigation needs for this area.

Section 4 Environmental Consequences
In numerous places throughout this section, the DEIS refers to Best Management Practices (BMPs) for water quality protection which would be required by the state-issued Water Quality Certification. The DEIS states that secondary impacts (referenced in the DEIS as indirect effects) to seagrasses are not anticipated due to the requirement of BMPs (pages 176 and 191); adverse effects should be negligible to hardbottom habitat because of the use of state-required BMPs (page 179); impacts to the water column (including marine and estuarine species) will be controlled through the use of BMPs (page 184-185); and BMPs will reduce potential impacts to turtle foraging habitat (page 199).

The FWC supports the concept that water quality BMPs could be developed to control and minimize some secondary impacts from project activities (e.g., sloughing, turbidity, sedimentation). Turbidity and sedimentation have been shown to affect coral settlement, growth rates and colony morphology (Rogers 1979; Rogers 1990). For seagrasses, the critical threshold for turbidity and sedimentation, as well as the duration that seagrasses can survive periods of high turbidity or excessive sedimentation vary greatly among species. The extent of damage to seagrasses is not simply a function of the size and scale of the dredging operation alone, but also depends on proximity to the seagrass bed, type and composition of the sediment, the way dredging equipment is used, and mitigating measures applied (Erftemeijer and Lewis 2006).

Secondary impacts can negatively impact FWC-managed species and their habitats, primarily coral reef and seagrass-dependent marine species. The FWC recommends that secondary impacts should be factored in to both project impact assessment and compensatory mitigation assessment for coral reef and seagrass habitats. FWC staff is available to assist the USACE with determination of secondary impacts.

Section 4.28 Environmental Commitments
The USACE has committed to conducting pre- and post-construction surveys and coordinating further with the resource agencies regarding mitigation analysis and the mitigation plan (page 179). The FWC supports this commitment and FWC staff will coordinate with the USACE and resource agencies beyond the planning-level analysis included in the EIS and mitigation plan.

Appendix C Federal Consistency Determination, #10 and #11
We request the DEIS language be modified to reflect language regarding Florida Statute Chapters 370 and 372 to reflect changes made to combined them into Chapter 379 Fish and Wildlife Conservation, and adopted into Florida's Coastal Management Program in 2009.

Appendix E Port Everglades Navigation Improvements-Draft Comprehensive Mitigation Plan and Incremental Cost Analysis

Section 4.1 Determining Mitigation Needs for Seagrasses

1) Seagrass mitigation requirements were determined using the State of Florida's Uniform Mitigation Assessment Method (UMAM). The full UMAM assessments were not provided in the DEIS for the project seagrass impacts at Port Everglades or for the proposed compensatory mitigating actions in West Lake Park (WLP). As a result, the FWC cannot determine what factors were taken into consideration for determining UMAM scores, associated mitigation needs, and proposed compensatory mitigating actions for seagrass impacts. The full UMAM assessment for both project impacts and proposed WLP mitigating actions (inclusive of Part 1 and full score sheets for Part 2) should be included in the DEIS along with a discussion of seagrass functions that were factored into consideration for determining UMAM scores, mitigation needs, and compensatory mitigating actions in this section. This information is necessary to accurately assess the potential impacts to fish and wildlife resources by the project.

   Since this information was not provided, the FWC provides the following information regarding seagrass functions necessary to consider when determining accurate UMAM scores, determining mitigation needs, and proposing compensatory mitigating actions for seagrass impacts.

   Seagrass located in close proximity to an inlet have been shown to serve specific and irreplaceable ecological functions that seagrass located further away from an inlet do not. These irreplaceable functions are highly valued, and should be reflected as such in both UMAM scoring criteria, identification of mitigation needs, and proposal of appropriate compensatory mitigating actions for seagrass impacts. Documentation of valuable ecological functions of seagrass in close proximity to a coastal inlet include:

- Habitat value during growth to maturity for gray snapper (*Lutjanus griseus*) and bluestriped grunt (*Haemulon sciurus*) is a function of distance from an ocean inlet (Faunce and Serafy 2007).

- The planktonic larvae of gag grouper (*Mycteroperca microlepis*) move into estuaries and settle in the first available habitat, including polyhaline seagrass beds near inlets (Ross and Moser 1995).

- Based on work completed in the Indian River Lagoon, Gilmore (1995) determined that seagrass habitats near ocean inlets offer optimum physical conditions with low variation in temperature and salinity and other physical parameters as well as proximity to ocean spawning sites for reef species. Therefore, seagrass habitats near inlets provide habitat for the most diverse fish communities and seagrass communities away from the inlets become less diverse.

- A faunal transition and fish community change takes place within 5 km (3.1 miles) of the ocean inlet to the lagoon as one proceeds away from the inlet (Gilmore 1995).

- Other studies (e.g., Bushon 2006; Turtora and Schotman 2010) have also linked species distribution and life history stages as a function of proximity to a coastal inlet.

If not already considered in the UMAM scores regarding habitat value, the above information should be factor into scores related to habitat utilization.

2) Paragraph 2 of this section states: "However, because mitigation construction has already been initiated, revised UMAM calculations during the upcoming Preconstruction Engineering and Design (PED) phase of the project will likely indicate that fewer functional units will be required. This is because the time lag factor (time to which mitigation reaches full function) in UMAM will be reduced or nearly eliminated by the time impacts occur." Mitigation construction has not yet been permitted or initiated, thus this statement is premature and does not recognize the full need for mitigation and the functional units required. In order to ensure that mitigation meets full function, particularly with regard to fish and wildlife habitat values, we recommend this statement be eliminated.

Section 4.4 Proposed Mitigation Plan for Seagrasses, page 15

1) A portion (one functional unit) of seagrass mitigation in West Lake Park is credited from establishing a manatee/seagrass protection area (MPA). The mitigating value of this MPA has been in question, and the FWC maintains that protecting existing seagrass resources does not replace the ecological functions of the seagrass resources permanently removed by the project. Additionally, the FWC is not clear by which legal mechanism this zone has been created. The FWC originally identified this issue for the USACE in June of 2008. Subsequently the issue has been identified by FWC staff during a number of project meetings, and was again documented in the FWC Second Interim IDEIS Comments, dated May 31, 2011 (comment #37). At this

time, the FWC recommends an alternative mitigation approach be developed for this one functional unit of mitigation credit.

2) If natural seagrass recruitment does not occur in the proposed seagrass-creation areas, the DEIS states that donor material will be planted based on guidance from Fonseca et al. (1998). This statement is not informative because there are a variety of seagrass transplanting methods (e.g. cores, peat pots, bare root/staple, etc.) described by Fonseca et al. *Halophila decipiens* is the dominant seagrass species at the WLP location, so it would be the best transplant species of choice. However, *H. decipiens* is fragile, and cannot be installed with the bare root/staple technique that is most commonly used for larger species such as *Halodule wrightii*. If *H. decipiens* plants are not carefully installed, their rhizomes will become dislodged from the sediment and the plants will float away because they are very shallowly rooted (i.e., roots barely penetrate the sediment surface). Information regarding the specific transplanting method, the species that will be used, where the donor material will be obtained from, and the planting density proposed is necessary for FWC staff to assist USACE staff in successfully creating a seagrass mitigation area. For instance, if *H. decipiens* is selected, the transplanting method must utilize a procedure where whole plants with sediment are removed and installed or the delicate rhizomes will be destroyed. It should be noted that no long-term, successful *Halophila* transplanting project has been documented in the peer-reviewed literature to date.

Section 4.5 Monitoring and Adaptive Management for Seagrass Mitigation, page 16

1) Paragraph 2 of this section states that forty paired, $1m^2$ quadrats will be randomly placed within the created seagrass habitat during each monitoring event. The small number of monitoring points relative to the large area that must be monitored (40 quadrats distributed over 8 acres = 5 m^2 per acre) may yield inaccurate results, particularly for patchy seagrass species such as *Halophila decipiens* and *Halophila johnsonii*. For this reason, FWC staff recommends that this section further discuss the monitoring methodology and rationale to provide the basis for determining both the number of quadrats and the number of monitoring points.

2) In paragraph 4 of this section, it is unclear what survivorship rates would be assessed in paired 1 m^2 quadrats. It would seem this paragraph intended to reflect that seagrass cover in WLP recruitment areas and natural seagrass beds will be assessed in paired 1 m^2 quadrats divided into 10-cm X 10-cm sections. Survival would only be assessed for transplanted seagrass, so paired quadrats would not be necessary. In addition, seagrass planting unit survival would not be estimated in a 1 m^2 quadrat divided into 10-cm X 10-cm sections – that technique would only be used to assess seagrass cover in the seagrass recruitment zones, natural seagrass beds, or transplanted zones after planting units coalesced. FWC staff recommends the USACE clarify the assessment methods in this section.

Section 4.6 Seagrass Mitigation Success Criteria, page 17

It may be unnecessary for the USACE to use the shoot count metric when determining cover as a success criteria. The FWC requests clarification regarding how target cover goals were determined, and identification of what is the cover of natural seagrass beds in the WLP region so FWC staff can help ensure the most effective methods are used. If the time-consuming shoot count metric is eliminated, this would enable the number of quadrats monitored for cover to be substantially increased while saving time. Sampling methods should address the monitoring goal, which in this case is achieving natural levels of seagrass cover in created seagrass beds.

Section 5.1 Determining Mitigation Needs for Mangrove Wetlands, page 18, paragraph 2
Paragraph 2 of this section states: "However, because mitigation construction has already been initiated, revised UMAM calculations during the upcoming Preconstruction Engineering and Design (PED) phase of the project will likely indicate that fewer functional units will be required. This is because the time lag factor (time to which mitigation reaches full function) in UMAM will be reduced or nearly eliminated by the time impacts occur." Mitigation construction has not yet been permitted or initiated, thus this statement is premature and does not recognize the full need for mitigation and the functional units required. In order to ensure that mitigation meets full function, particularly with regard to fish and wildlife habitat value, we recommend this statement be eliminated.

Section 5.5 Monitoring and Adaptive Management for Mangrove Wetland Mitigation, page 21

1) The methodology proposed in the DEIS to monitor mangrove recruitment is a 2-m-wide belt transect placed along the long axis of each recruitment zone. It would be more appropriate to monitor recruitment over the entire zone such as proposed for seagrass monitoring (i.e., random points distributed over the entire site so results can be generalized over the entire area). The FWC recommends modifying the monitoring methodology for recruited mangrove trees once they are > 1.5 m tall, to include trees over the entire recruitment zone rather than those within a 2-m-wide belt transect.

2) In order to understand how monitoring will be conducted and assess the success of mitigation to ensure restoration of fish and wildlife habitat value, the FWC requests additional information in this section regarding the following:
   - "Aerial coverage" – what does it refer to, canopy cover or actual tree cover of the sediment surface?
   - What is the duration and frequency of "aerial coverage" measurement?
   - How will the number of sampled trees be determined, how will the particular trees be selected, and how will overall mangrove health be assessed?

Section 5.6 Mangrove Wetland Mitigation Success Criteria
Section 5.5 states that data to be collected during monitoring will include height, spread, and diameter at breast height; however, there is no discussion of how this information will be used. We recommend this section of DEIS more thoroughly address how this information will be used to determine mitigation success.

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Broward
SCH
2013-02684

COUNTY: BROWARD

DATE: 6/26/2013
COMMENTS DUE DATE: 8/5/2013
CLEARANCE DUE DATE: 8/25/2013
SAI#: FL201306266640C
REFER TO: FL200103150126C

MESSAGE:

STATE AGENCIES	WATER MNGMNT. DISTRICTS	OPB POLICY UNIT	RPCS & LOC GOVS
COMMUNITY PLANNING	SOUTH FLORIDA WMD		
ENVIRONMENTAL PROTECTION			
FISH and WILDLIFE COMMISSION			
X STATE			
TRANSPORTATION			

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evaluation and is categorized as one of the following:

- _ **Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.**
- X **Direct Federal Activity (15 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.**
- _ **Outer Continental Shelf Exploration, Development or Production Activities (15 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.**
- _ **Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.**

Project Description:

DEPARTMENT OF THE ARMY, JACKSONVILLE DISTRICT CORPS OF ENGINEERS - DRAFT FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT, NAVIGATION STUDY FOR PORT EVERGLADES HARBOR - FORT LAUDERDALE, BROWARD COUNTY, FLORIDA.

To: Florida State Clearinghouse

AGENCY CONTACT AND COORDINATOR (SCH)
3900 COMMONWEALTH BOULEVARD MS-47
TALLAHASSEE, FLORIDA 32399-3000
TELEPHONE: (850) 245-2161
FAX: (850) 245-2190

EO. 12372/NEPA

- [x] No Comment
- [ ] Comment Attached
- [ ] Not Applicable

Federal Consistency

- [x] No Comment/Consistent
- [ ] Consistent/Comments Attached
- [ ] Inconsistent/Comments Attached
- [ ] Not Applicable

From:

Division/Bureau: Historical Resources

Reviewer: Michael Hart [signature] DSHPO

Date: 7/2/13

RECEIVED
JUL 11 2013
DEP Office of Intergovt'l Programs

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

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RICK SCOTT
GOVERNOR

CARLOS LOPEZ-CANTERA
LT. GOVERNOR

HERSCHEL T. VINYARD JR.
SECRETARY

MEMORANDUM

TO: Lauren Milligan, Florida State Clearinghouse Coordinator
Office of Intergovernmental Programs

FROM: Mark Thomasson, P.E., Director, Division of Water Resource Management

Kevin Claridge, Director, Florida Coastal Office

Parks Small, Chief, Bureau of Natural and Cultural Resources
Division of Recreation and Parks

SUBJECT: Department of the Army, Jacksonville District Corps of Engineers
Draft Feasibility Report and Environmental Impact Statement, Navigation Study for Port Everglades Harbor – Fort Lauderdale, Broward County, Florida.
SAI # FL201306266640C

DATE: June 20, 2014

The *updated* Draft Feasibility Report and Draft Environmental Impact Statement (EIS) and the Biological Opinion for the Port Everglades Harbor Navigation Study have been reviewed by the **Division of Water Resource Management** (DWRM). The DWRM staff has been in communication with the U.S. Army Corps of Engineers (USACE) and the Florida Fish and Wildlife Conservation Commission, as well as the Department's Florida Coastal Office and Division of Recreation and Parks, regarding this project for quite a few years, and the Department agreed to become a Cooperating Agency in November of 2007. To date, our efforts to improve the environmental assessment of impacts and to agree on acceptable minimization and mitigation for those impacts have not been entirely successful. We understand the National Marine Fisheries Service (NMFS) has approved a conceptual mitigation plan and has committed to work with this agency to assist in converting their review and scoring to the state required format; however, that has not yet been done. Completion of that effort may satisfy some of the conditions below.

The USACE applied for a major modification to the existing maintenance dredging permit for Port Everglades to include this expansion on July 1, 2013 and subsequently withdrew the application on July 30, 2013. Staff review and comparison of the Draft EIS, permit modification application, and subsequent responses to the draft conditional concurrence determination have raised a number of issues. Previous comments, italicized below, addressed both federal consistency and permitting issues. However, as the modification was withdrawn, the remaining issues are limited to consistency review on the Draft EIS and Feasibility Report.

Since the proposed activities will require state water quality certification in the form of an Environmental Resource Permit and sovereignty submerged lands authorization from the DWRM, as well as the disposition of state-owned lands by the Board of Trustees of the Internal Improvement Trust Fund (Board of Trustees or Governor and Cabinet), the project must meet provisions of Chapters 253, 258, 373 and 403, *Florida Statutes* (F.S.). Should beach placement of sand from the inlet be considered, as proposed in the permit modification application, the provisions of Chapter 161, F.S., shall also apply and a Joint Coastal Permit would be required rather than an Environmental Resource Permit. The DWRM finds the updated Draft EIS and Feasibility Report to be "conditionally consistent" with the Florida Coastal Management Program and makes the following recommendations to provide reasonable assurance that the project will meet state water quality standards, will not be contrary to the public interest, and the use of sovereignty submerged lands and state-owned natural resource lands will meet the requirements for authorization by the Board of Trustees:

1. **Flooding and Flushing Model** – *Deeping the entrance channel, which essentially would increase the cross-sectional flow area, could affect the tidal hydraulics within the confined interior tidal body at a distance from the entrance channel. Should the propagation of the tide through the inlet have the properties of a shallow water wave, the tide range should not be reduced. The celerity of the tide wave would increase where deepened and the timing of the peak current and slack tide would occur earlier away from the entrance channel. Reasonable assurance is required to show that the project will not cause flooding of properties within the confined interior water body. Therefore, provide a flooding model and analysis to evaluate potential inland flooding impacts associated with deepening the channel. On the ebb tide, water is advected seaward through the entrance channel that contains higher concentrations of nutrients and other contaminates compared to levels in the open coast waters. Enlargement of the channel brings the possibility of increasing the flux of these substances out of the inlet and into the coastal waters. Furthermore, the vertical velocity and density structures of tidal flows may be stratified and dependent on the tidal phase. The RMA-2 is a depth averaged model not intended to resolve the vertical features of the channel water column. The field-measurements requested above are necessary to validate the applicability of the RMA-2 model as well as calibrate the model. [§ 373.414(1), F.S.]*

   The USACE responded to the Department's request for flood modeling with a statement that modeling is not required because such modeling for port expansions at Jacksonville, Palm Beach and Miami did not appreciably impact storm surge and, therefore, the USACE concluded that flooding due to port expansion at Port Everglades is not expected. The results of a hydrodynamic model that was not calibrated or verified was referenced as additional support for this expectation of no flooding.

   The DWRM does not agree that this conclusion can be made from the numerical modeling results at these other port projects because the physical site conditions are not similar. The results of the unverified hydrodynamic model are not adequate as additional support for the USACE conclusion. Similarly, the USACE conclusion regarding the possibility of increasing the flux of nutrients and other contaminants out of the inlet and into the coastal waters is not supported by the hydrodynamic model.

To be consistent, the Department requests hydrodynamic modeling calibrated and verified for Port Everglades that provides adequate engineering data on flooding and flushing. The Department's guidelines for documenting numerical modeling studies can be located on our website, under "Engineering and Reporting Guidelines" at: http://www.dep.state.fl.us/beaches/publications/tech-rpt.htm#Discussion. Data other than numerical models may be considered on a case-by-case basis.

2. **Hardbottom Impacts** – *The Draft EIS does not clearly describe how the hardbottom impact areas were determined. The Draft EIS states that Dial Cordy mapped the area using towed video cameras and benthic assessments; however, no mapping protocols were provided to determine how the mapping was performed. Please provide the estimated acreage of all potential direct and secondary hardbottom impact areas (including the estimated acreage of hardbottom present on the west side slope of the second reef and the east and west side slopes of the third reef) using updated cartographic data (i.e., LADS survey of 2009). Please also provide a formal description of each potential direct and secondary hardbottom impact area with quantitative data on each major functional group (e.g., macroalgae, turf algae, sponges, corals, etc.) and species-indicators (e.g., scleractinian corals, octocorals, etc.), including cover, density, size class distribution, etc., and description of methods used to obtain these data. [§ 373.414(1), F.S.]*

   During permitting, the DWRM will need up-to-date data in sufficient detail for its staff to perform a Uniform Mitigation Assessment Method (UMAM) analysis. The data utilized in the impact assessments, especially in the deeper areas within the channel that were not surveyed (*i.e.*, slopes below -57 ft., and fragments of the third reef within the channel), yet are subject to both direct and indirect impacts, is not sufficient for a UMAM analysis. Although the USACE reports their staff cannot dive in the channel, the state has been to the site and has data showing the high diversity and value of the resources in the channel expansion areas. The impact and mitigation assessment should include these data.

   The applicant will also need to provide a thorough pre-construction survey to accurately classify the habitat and verify the predicted information and potentially adjust mitigation and / or compensatory mitigation allowances.

3. **Mangrove/Seagrass Impacts** – *A map depicting the mangrove and seagrass impact areas was provided in the Draft EIS (Figure 71); however, these areas are difficult to view and evaluate because the scale is small. Please provide a graphic representation of the mangrove and seagrass impact areas with a larger scale. Please show the*

boundaries of the project in relation to the mangrove and seagrass impact areas on the map.

Please provide a detailed description of each mangrove impact area that accurately characterizes the ecological values of the area and functions provided including: types of mangroves, coverage of each type of mangrove, height, general health of the mangroves, coverage and density of nuisance or invasive exotic plant species, wildlife utilization and type of use, and whether any portion of the assessment area has been used as mitigation for a previously-issued permit.

Please provide a detailed description of each seagrass impact area that accurately characterizes the ecological values of the area and functions provided including seagrass species, and the coverage and spatial distribution of each species. Please provide the methodology used to characterize the seagrass areas.

This information was provided in the response, and although the DWRM still has questions and recommendations, these issues could be worked out in the permitting phase.

Secondary Impacts – Identify any secondary impact areas where mangroves and seagrass are in close proximity to the project boundaries. If none are expected, provide an explanation as to how the secondary impacts to these communities will be prevented. [§ 373.414(1), F.S.]

A monitoring plan, designed to measure potential secondary impacts, and an adaptive management plan to cover the associated mitigation, if these impacts should occur, is needed to assure consistency.

4. **Biological Monitoring Plan** – *A detailed Biological Monitoring Plan will need to be provided and, if separate, a Sedimentation and Turbidity Monitoring Plan that measures the biological stress at fixed stations within seagrass and hardbottom resource areas adjacent to the proposed work sites that may experience significant amounts of impact due to turbidity, sedimentation, sloughing or direct physical effects (e.g., anchor or spud placement).*

The provided Miami Harbor monitoring plan is not sufficient to determine potential impacts at Port Everglades. The DWRM worked on and provided a detailed draft of monitoring items needed, including appropriate monitoring locations, appropriate sedimentation monitoring, and appropriate during-construction monitoring to detect potential impacts, including those resulting from excessive turbidity. Our recommendations were not incorporated. A more appropriate monitoring plan which enables accurate detection of project related impacts is required in order to obtain consistency on this matter. The Department suggests referring to the monitoring plan draft mentioned above. [§§ 373.414(1) and 161.041(4), F.S.]

5. **Minimization of Impacts to Hardbottom and Coral Reef** – *DWRM acknowledges that scleractinian corals greater than 10 cm in height or diameter will be transplanted prior to dredging to minimize direct impacts. Corals of a size class 10 cm to 25 cm are the major reproduction pool, as they have achieved a stage of puberty, and they are two orders of magnitude greater in number than corals of class >25 cm, and an order more in diversity (number of species). To minimize the direct impacts to the greatest extent practicable, DWRM staff recommends that, in addition to transplanting all scleractinian corals greater than 10 cm in height or diameter, at least 2,000 octocorals greater than 15 cm in height and at least 300 sponges (Xestospongia muta, Geodia neptuni, Spheciospongia vesparium and Ircinia strobilina), which includes at least 200 sponges greater than 25 cm in diameter and at least 100 sponges greater than 40 cm in diameter, be transplanted as well. [§ 373.414(1), F.S.]*

   The DWRM documentation on species at the site supports inclusion of additional species in the transplantation plan. The USACE response indicates only transplantation of select coral species and did not include octocorals and sponges which, according to our analysis, does not provide adequate minimization measures for the project. The applicant is required to minimize impacts to natural resources, not exclusively corals. In order to obtain consistency with minimization requirements at the state level, the USACE transplantation plan needs to include corals, octocorals, and sponges of specific size / species.

6. **Mitigation** – *The Draft EIS described two potential mitigation options to offset direct impacts to hardbottom. One mitigation option (preferred by the USACE) involves creation of an artificial reef. The other mitigation option (preferred by the National Marine Fisheries Service) involves coral propagation. To mitigate for hardbottom impacts, DWRM staff prefers a combination of both mitigation plans to offset impacts to reef substrate, and creation of onshore and offshore nurseries for corals, octocorals and sponges to enhance the recruitment in natural hardbottom. Please provide a mitigation plan that incorporates both mitigation options. Please include a section for mitigation that is suitable to address impacts due to turbidity and sedimentation.*

   The mitigation plan needs to include functional offsets based on the Uniform Mitigation Assessment Method (UMAM) for both direct AND secondary impacts. Although UMAM will be conducted by the Department, the correct estimates of direct and secondary hardbottom impacts must be provided beforehand.

   In response to concerns about an all boulder mitigation plan being utilized, the USACE proposed a blended mitigation plan. Although the DWRM is in agreement with a blended mitigation plan, and acknowledges that the NMFS has reviewed the plan and scored the plan with their Habitat Equivalency Analysis (HEA), we do not have enough information to show that the plan proposed by the USACE adequately offsets direct and secondary hardbottom impacts. We further understand that NMFS has committed to provide their expertise in assisting the DWRM with converting their HEA scoring analysis to the state required UMAM analysis; however, at this time it has not occurred. To obtain consistency on this matter, the mitigation proposal provided during permitting will have to include sufficient detail and proposed mitigation to adequately offset the project impacts. [§ 373.414(1), F.S.]

Degradation to natural communities adjacent to the project area is likely, due to turbidity and sedimentation. The DWRM recommends that the USACE consider up-front mitigation for degradation of a defined area adjacent to the excavation areas. Such a strategy would avoid any additional mitigation associated with time lag related to the post-construction monitoring period, and possibly avoid the additional costs of remobilization to create additional mitigation in the future.

The USACE addressed mitigation of secondary impacts to 2% of the resources adjacent to the channel and to 10% downslope of the -57 ft. dredge limits. For consistency purposes, an adequate monitoring and adaptive management plan that includes the entire area of secondary impacts will be necessary to assure that the predicted / contingency mitigation is adequate. Without these mitigation issues being fully addressed, the Department is concerned that there is not enough money allocated to mitigation and contingency mitigation to adequately offset the adverse impacts of the project, therefore, the USACE's proposed funding amount for mitigation does not adequately reflect the Department's requirement under Chapter 373, F.S., relating to the public interest.

The Draft EIS states that one mangrove functional unit will be created at West Lake Park to offset 1.16 acres of mangrove impacts, and three seagrass functional units will be created at West Lake Park to offset 4.01 acres of seagrass impacts. Please indicate how the amount of functional units was determined through the UMAM. Also indicate how many acres of mitigation will be provided by one mangrove functional unit and three seagrass functional units. Please provide a letter from either the South Florida Water Management District or Broward County authorizing the proposed mitigation at West Lake Park, and a statement that the proposed mitigation is consistent with the overall mitigation plan for West Lake Park. Please provide a detailed mitigation plan for both mangrove and seagrass impacts including maintenance, monitoring and construction sequence and techniques. Staff requires this information to conduct UMAM for each type of impact. [§ 373.414(1), F.S.]

The USACE has provided further details regarding the mitigation calculations. The DWRM still has questions and concerns on the proposed mitigation at West Lake Park, but can address these issues in the permit phase.

<u>Please be advised that further detailed comments regarding coral and hardbottom impacts, assessment, monitoring and mitigation are provided on Pages 8 through 17 of this memorandum by the Department's Coral Reef Conservation Program.</u>

Thank you for the opportunity to comment. For further information and assistance, please contact Dr. Lainie Edwards, Program Administrator, DWRM, at (850) 245-7617.

The Department's **Division of Recreation and Parks** also appreciates the opportunity to participate in the review of this important project. The following condition (provided by staff of the Bureau of Parks District 5, Office of Park Planning, and Bureau of Natural and Cultural Resources) must also be addressed to ensure compliance with the provisions of Chapters 253 and 258, F.S., regarding impacts to state park lands:

7. **John U. Lloyd Beach State Park Impacts:**

   The preferred alternative indicates that the submerged bulkhead would be installed on the east side of the channel. Based on the maps provided, the bulkhead appears to be recommended in a location that would cut across the park's office/shop area. The proposed location would be quite close to several park staff residences and the ground solar array in that same area. The response provided by the USACE on March 27, 2014, indicates that no further minimization or avoidance of impacts to park lands is possible. However, none of the proposed mitigation would provide on-site improvements to offset the impacts (direct and indirect) to the park. Please contact Division of Recreation and Parks staff to discuss opportunities to mitigate for losses to natural resources, visitor recreation experiences, and potential impacts to park facilities.

   If blasting is required during the dredging process or for the placement of sheet pile bulkhead, impacts to imperiled species, fragile submerged habitats, park resources and facilities, and the park visitor experience could occur. Please provide information on how these impacts will be avoided or minimized. If these impacts cannot be avoided or minimized, please provide information on mitigating the impacts.

   Board of Trustees Authorization – As noted in the Draft EIS, impacts to the state park must meet the Board of Trustees' 1988 <u>POLICY FOR INCOMPATIBLE USE OF NATURAL RESOURCE LANDS</u>. If the parties involved in the proposed disposition of state lands (*i.e.*, Board of Trustees, Division of Recreation and Parks, Broward County, and USACE) agree that Broward County should obtain fee-simple titled ownership of the affected bulkhead area, the County would apply to the Department's Division of State Lands to have the area designated as surplus and sold/deeded to Broward County. If it is determined that the Board of Trustees will retain fee-simple ownership, the County would either: apply for a lease from the Board of Trustees for the bulkhead area, apply for a sublease from the Division of Recreation and Parks, or apply for an easement from the Board of Trustees with the Division of Recreation and Parks' consent.

> Any application to use state land which would result in significant adverse impact to state land or associated resources shall not be approved unless the applicant demonstrates there is no other alternative and proposes compensation or mitigation acceptable to the Board of Trustees under § 18-2.018(2)(i), *Florida Administrative Code* (F.A.C.). Any requested use of state land which has been acquired for a specific purpose, such as conservation and recreation lands, shall be consistent with the original specified purpose for acquiring such land in accordance with § 18-2.018(2)(c), F.A.C. Applicants applying for a lease or easement across state land which is managed for the conservation and protection of natural resources shall be required to provide net positive benefit as defined in § 18-2.017(38), F.A.C., if the proposed lease or easement is approved. [§§ 253.03, 253.034 and 253.04, F.S.]

For further information regarding the above condition requirements, please contact Mr. Gregg Walker in the Division of Recreation and Parks at (850) 245-3104.

The Department's **Florida Coastal Office, Coral Reef Conservation Program** (CRCP) staff advises that the provisions of §§ 253.03 and 253.04, F.S., charge the Board of Trustees with the duty to administer and protect sovereignty submerged lands. Chapter 373, F.S., also contains several provisions relating to the public interest in maintaining fishing and recreational values as well as conserving fish and wildlife resources in surface waters and wetlands of the state [§§ 373.414(1)(a)2, 4 and 7, F.S.]. Rule 68B-42.009, F.A.C., explicitly prohibits the take, destruction or sale of marine corals and sea fans. Section 403.93345, F.S., the *Florida Coral Reef Protection Act*, provides for protection of coral reefs and associated reef resources on sovereignty submerged lands off the coasts of Martin, Palm Beach, Broward, Miami-Dade and Monroe Counties. Under this law, the Department is authorized to protect coral reefs through timely and efficient assessment of damages, including civil penalties, resulting from vessel impacts (*e.g.*, anchoring, cable drags, grounding) to coral reefs.

The CRCP finds the Draft EIS and Feasibility Report to be "conditionally consistent" with the Florida Coastal Management Program and makes the following recommendations:

1. Analysis of Direct and Indirect Impacts.

   a. 2006 USACE Reef and Hardbottom Survey: Previously submitted comments regarding the 2006 reef, hardbottom surveys, and channel habitats remain unaddressed. Surveys conducted in the Port Everglades Outer Entrance Channel (OEC) by the Department's DWRM indicate a high species diversity and abundance of scleractinian corals presence in the channel and on the channel walls. Documentation and photos of rich coral community inside the OEC have been provided to the USACE. Without accurate surveys, benthic organism impacts cannot be accurately determined.

The Draft EIS states that, "*Little information has been collected on the biota of the channel and adjacent zones due to the hazard of sampling this area.*" Hazards listed include frequent vessel traffic and substantial currents, both of which could be overcome by a coordinated effort. Communication with the Port, vessel pilots, and U.S. Coast Guard (including topside support from the USCG Auxiliary), could be achieved and would reduce and mitigate vessel traffic issues.

While it is accurate that there are substantial currents in the area, they are frequent and considered to be standard working conditions for the entire region. Additionally, updated *in situ* habitat surveys need to be conducted, including sites that are actually within the Outer Reef direct impact area to accurately quantify the benthic organisms. As this area is not officially in the navigable channel, it is not clear why there are restrictions on USACE contractors being *in situ* to survey this area.

b. **Direct impacts adjacent to and below actual dredging depth:** In June 2008, the USACE informed the NOAA National Marine Fisheries Service (NMFS) that coral reefs located deeper than authorized dredging depth, but still within the proposed expansion to the federal channel would be considered indirect impacts. The Department's CRCP staff respectfully disagree with the USACE conclusion; we believe that coral reefs located within the federal channel that are not dredged but are immediately adjacent to (or below) the dredging depth would be severely and permanently injured through the physical processes of rubble movement and the consistent scouring from vessels transiting the channel. Additionally, these areas will be permanently impacted due to the proposed post-dredging operations and maintenance whereby, "*a drag bar, chain, or other item may be pulled along the channel bottom to smooth down high spots and fill in low spots.*"

These direct impacts are not precisely described in the Draft EIS and should not be included in the discussion of impacts from turbidity and sedimentation, which may be as severe and permanent by occurring through a different mechanism. However, the physical impact to coral reef structure and the biological response to these types of impacts would be different. Each coral reef impact area and type needs to be clearly identified as an impact polygon on a map with a narrative that explains how the impact area was calculated. This detail is needed in the Draft EIS, and similar detail is missing for indirect and direct impacts from anchoring and vessel operations.

The USACE states that the amount of Outer and Middle Reef area to be directly impacted above 57 ft. equates to 15.17 acres. NMFS has determined that impact to the Middle and Outer Reefs, when taking into account the amount of affected reef area below 57 ft., is a total of 21.65 acres – it is requested that this discrepancy in impact acreage be resolved.

c. **Indirect area perimeter and monitoring:** The Draft EIS states that, "*In order to address potential indirect impacts, USACE will monitor a perimeter up to 150 meters away from the dredge footprint (north and south of the channel), and mitigate for apparent effects directly linked to the dredging.*" CRCP staff do not agree that 150 meters surrounding the dredge footprint is sufficient in scope for monitoring (and potentially mitigating for) indirect impacts. The PIANC (2010) report states, "*In some cases, the impact may be confined close to the work area, [while] in others the prevailing currents may transport fine sediments over large distances, with documented cases of impacts occurring > 70 km [approx. 43.5 miles] from the work site.*" Without monitoring a larger area, it may be difficult/limiting to determine if the project has impacted the surrounding reef community and, accordingly, there would be no mitigation requirement for these impacts.

As a recent example, a 750-meter mixing zone variance was requested for the current Miami Harbor construction. While a mixing zone variance has not yet been requested for this project, CRCP staff suggest that the USACE use a similar mixing zone area to accurately plan monitoring and mitigation for indirect impacts.

The proposed sampling design does not provide enough detail nor does it provide a power analysis that will allow determination of sample size needed to detect significant differences. Additionally, a new study on the tidal velocity and flow of the water through the Port Everglades Inner Entrance Channel (IEC) has revealed a stratified water column – showing that it is possible for the upper part of the water column to flow in an opposite direction from the lower part of the water column (Stamates *et al.* 2013). This has major implications for turbidity and sedimentation transport, as well as impact monitoring, since previous monitoring protocols were likely not correctly designed to be able to detect changes or impacts. These results will need to be integrated fully into any indirect impact monitoring plans created for this project.

d. **Snb-lethal and lethal impacts:** Although healthy coral reef benthic organisms can often tolerate turbidity and sedimentation from short-term events, the coral reefs in the vicinity of Port Everglades are already under significant stress from other threats (*e.g.*, land based sources of pollution). While we support the USACE's effort to reduce these indirect impacts using Best Management Practices (BMPs) developed by the Southeast Florida Coral Reef Initiative (SEFCRI), CRCP staff are concerned that with such a relatively long-term dredging proposed for this project (estimated from 11 months to 3 years) there may be sub-lethal (*i.e.*, reduced growth rate, bleaching, reduced reproduction) and possibly lethal (mortality, change in species composition) impacts associated (PIANC, 2010). Stress monitoring is still evolving due to the intricacies of understanding individual colony and community stress reactions. As shown in Figure 1, scleractinian corals often have sub-lethal stress effects that can't be easily seen. It is recommended that the benthic monitoring plan take into account these impacts.

Additionally, as recommended by the SEFCRI BMPs document cited in the Draft EIS, dredging should be carefully scheduled to avoid sensitive resource periods such as coral spawning events.

2. Coral translocation/transplantation conditions.

While the Draft EIS states that conditions regarding the transplantation of scleractinian corals will be developed during the pre-construction, engineering and design (PED) phase, it is noted that there are inconsistencies in the sizes of the colonies that will be transplanted. We suggest consideration of the NMFS conditions that require the relocation of: all corals from impact areas listed under the Endangered Species Act, regardless of size; a subset of massive corals and all corals proposed to be listed under the Endangered Species Act that are 5 cm in diameter or larger; and all other corals greater than 10 cm diameter.

Additionally, we suggest consideration for transplanting of the dominant species in these habitats, specifically, octocorals and sponges. They both provide many bioservices including water purification, creating 3-dimensional habitat, and support for a multitude of other important organisms. Extensive dredging projects pose an environmental risk to these communities through increasing turbidity, reducing light, and smothering by sedimentation.

3. Habitat Equivalency Analysis (HEA).

One of the most important variables needed to conduct the HEA is an accurate impact area. As mentioned above, there have not yet been accurate direct and indirect impact areas provided by the USACE; therefore, the HEA presented in this Draft EIS cannot be adequately reviewed at this time. Reaching an agreement on impact assessment is crucial to informing compensatory mitigation. Once impact areas are determined, the HEA must be run again and reviewed by Resource Trustees.

CRCP staff has identified concerns regarding the way the current HEA was conducted, including the following:

a. **Inappropriate use of discount rate:** The USACE's decision to use no (or rather a 0%) discount rate is not an appropriate use of this economic model. Published literature on the HEA, specifically regarding coral impacts, supports the use of a 3% discount rate. As the USACE uses a discount rate of 3.75% in their Draft EIS Economic Analysis, it is unclear why it is being inconsistently applied in the 'Modified HEA.'

b. **Recovery rate:** As stated by the USACE, "*For the purpose of the Port Everglades HEA, the method employed by the Corps uses a Landscape HEA with stony corals as the representative proxy for the entire habitat affected. While stony coral coverage is <1% in the project footprint and vicinity (Gilliam et al. 2004, DC&A 2008), we did not use a proportional analysis to calculate the coral impacts. Instead, the losses are* *calculated as the amount of time it would take for the slowest-growing members of the ecosystem, in this case the stony corals, to recover to baseline, for the entire project footprint.*"

CRCP staff support the use of stony corals as the proxy in this model; however, the USACE's proposal to use a 50-year recovery rate for direct impacts and for the compensatory action (boulders) to reach maturity is likely underestimated given the age of the oldest corals in the vicinity is in excess of 100 years.

Dr. Richard Dodge, Dean of the NSU NCRI and HEA expert, conducted an independent technical review of the [US]ACE's HEA values and outputs. Notably, he was unable to replicate the HEA based on the input provided by the USACE. Working with NMFS, he used corrected values (*e.g.*, 3% discount rate, more accurate impact areas, etc.) and created an 'Alternate HEA' requiring an additional 32 acres of mitigation than the USACE's 'Modified HEA.' In addition to the same concerns stated above, his analysis found the following:

- "*The HEA inputs and results in Appendix E2 and not the same as those of the Cost Analysis.*
- *Many of the DEIS HEA input parameters used by the ACE are not supported by the best available science.*
- *The inputs chosen by the ACE for their HEAs underestimate amount of mitigation required.*
- *An Alternate HEA has been developed as part of these comments using: corrected direct impact areas for the Outer and Middle Reefs to include the area below 57'; 3% discount rate; and corrected equivalence that boulders upon maturity reach 50% of services of the natural reef.*
- *The ACE DEIS HEA for Scenario 2 in the DEIS Appendix E Cost Analysis requires 32 acres less mitigation than the more correct Alternate HEA.*
- *Accordingly ACE project mitigation costs are significantly underestimated by using the underestimated mitigation amount.*
- *Table 9 of the Cost estimate there is no justification given for using a much small $ amount for cost per acre of boulders with transplants.*
- *The ACE plan lacks input from the ACE's independent technical review performed by Battelle.*"

4. Alternative Mitigation Projects and Cost Estimates (Revised Plan – February 2014).

a. **Repair of grounding sites and subsequent coral installation (transfer from impact sites):** Please revise first sentence as the Southeast Florida Coral Reef Initiative is not related to these grounding sites. The Department's CRCP is the lead resource trustee for un-permitted reef injuries in the southeast Florida region, and is the appropriate entity to cite. Restoration of two of the grounding sites is currently underway. While restoration efforts at the additional sites may be warranted, CRCP staff feel that 10.6 acres is an over estimate of these areas. Coordination with CRCP will be required if this alternative is selected. Additionally, the stated estimates of 30 years until 'substantial functional productivity' is reached after restoration – and 'shortened to 10-20 years if corals are transplanted' are unsupported. Please provide citations or remove.

b. **Artificial reef creation using of [sic] quarried or dredged rock:** Upon maturity, boulders themselves, even with stony coral transplants attached, may provide similar but not 100% full ecological services as those of the natural reef. In Miami-Dade County, a 20-year monitoring program was developed to assess the efficacy of an artificial reef project as mitigation for natural reef impacts through the evaluation of colonization and succession of assemblages on two types of artificial reef materials, as well as comparisons to the adjacent natural reefs (Sathe *et al.* 2011). The Year 12 Monitoring Report states, "*The similarity between [natural and artificial] sites does not appear to be converging over time, rather maintaining distinct separation after twelve years, and possibly showing divergence in similarity.*" A Department CRCP study conducted by Gilliam (2012) concluded the length of time boulder reefs require to mitigate lost reef resources in southeast Florida, assuming a total loss of the impacted community from events such as dredging, exceeds the age of the oldest boulder reef assessed in this study (17 years).

c. **Blending of components from various mitigation alternatives/"Reef Creation with Coral Outplants":** CRCP staff does not support the use of artificial boulder reefs as the only mitigation option; however, we do support their limited use as part of a suite of mitigation projects. We support this option [formerly the Preferred Reef Mitigation Alternative 2 (NMFS-Developed Plan)] as the primary way to mitigate for the lost ecosystem services of the benthic veneer. This, coupled with limited use of boulders to support the propagation nurseries (to mitigate for the volume of Outer Reef that will be permanently lost), is a more appropriate scale and type of mitigation.

   We also support the statement that, "*decisions regarding which species to propagate and outplant (in addition to staghorn coral) and the balance (relative percent-cover, or relative population densities) among all species would be based on findings from the most recent coral restoration studies, historical survey data, and results of ongoing monitoring throughout the project area.*"

5. Construction/Initial Cost per Hardbottom Habitat Functional Unit.

The USACE's proposals underestimate the true cost of replicating the lost habitat which must take into account geological structural loss (*i.e.*, reef framework), biological structural loss (*i.e.*, size and types of benthic organisms), changes in habitat characterization (*e.g.*, depth, light penetration, temperature, etc.), and long-term (20+ years) monitoring to assess success of the project.

In 2014, as part of the Reef Injury Prevention and Response Program, the Department's CRCP awarded a contract for large scale, deep water reef restoration and coral relocation including the actual costs of engineering design, permitting, and construction implementation for primary restoration at two historic Broward County grounding sites – the *Spar Orion* and *Clipper Lasco.* Restoration costs included appropriate biological and habitat characterization surveys, construction of a limestone boulder reef (3 ft. x 3 ft. minimum) including grout, stony coral transplantation (over 5 cm), long-term monitoring, and all associated permitting and reporting requirements. The total costs were $3,254 per square meter ($m^2$) – roughly $12 Million (M) per acre. The value of coral reef resources designated by the Florida Legislature under the 2009 *Florida Coral Reef Protection Act* (§ 403.93345, F.S.) is $1,000 m^2 – approximately $4 M per acre.

The previously reviewed Interim Draft EIS (2012) stated that, "*The total cost of reef/ hardbottom mitigation is projected to be $32.44M.*" This was based on the USACE's 15.32-acre direct impact estimate – equating roughly $2.1 M per acre. However, the current Draft EIS states that the "*total estimated costs for this alternative, which includes the cost of coral translocation, is estimated at $20.13 M.*" Based on the currently proposed 15.17 acres, this effectively reduces the cost per acre to $1.33 M. This is further reduced if the additional 6.48 acres of direct impact below 57 ft. is taken into account.

6. Changes in Hydrology.

Extensive studies on changes to the sediment budget, changes to freshwater and saline water regimes, and hydrographic surveys were completed for the scoping of the feasibility of this project. However, this information was not used to inform the discussions on potential impacts that will occur to larval distribution or sedimentation on reefs and reef resources after project completion. The Draft EIS references how the sediment budget is not likely to have a cumulative adverse effect on the geology or coastal sediment budget/transfer for the area, but does not use this information in discussing the biological components that may potentially be impacted by these permanent changes.

a. **Impacts to nearshore water quality:** The Draft EIS states that, "*Water quality impacts would only be temporary due to construction activities, and the project would not result in any foreseeable future actions that would result in a cumulative effect.*" An independent technical review was conducted by Jack Stamates of NOAA's Atmospheric and Oceanic Meteorological Laboratory and he states the following:

"*On the ebb tide, water is advected seaward through the Port Everglades Inner Entrance Channel (IEC). Several studies have shown that this water contains higher concentrations of nutrients and microbial contaminates compared to levels typically seen in the coastal ocean [Stamates et al. 2013, Fusch et al., 2011]. There is concern that these substances have the potential to degrade the coastal environment.*

Enlargement of the channel brings the possibility of increasing the flux of these substances out of the inlet and into the coastal ocean."

b. **Potential loss of larval transport connectivity:** One such potential change is the transport of larvae. Although larval impacts are discussed within the Blasting impacts section, there doesn't seem to be any review of how the changes in hydrology from this project will impact their distribution and concentration. As the last remaining nearshore mangrove community in Broward County, the West Lake Park Mitigation Area is a nursery for many juvenile species that will eventually inhabit the offshore coral reef community. The seagrass habitats within the Port may act as stepping stones for these juveniles as they make their way offshore. Once the larvae and juveniles make their way into the IEC and OEC, the stratified water column presumably acts as a direct transport to the open reefs. Currently, the lower different layers of the water column are likely dispersed when they reach the Middle and Outer Reefs – allowing the larvae and juveniles to settle the local reef community. However, if wide swaths of Middle and Outer Reef are removed, the hydrology of the OEC will change substantially, and the larvae and juveniles may be washed out to sea.

Please contact Mr. Kevin Claridge, Director of the Florida Coastal Office, at (850) 245-2101 for additional information and assistance.

References and Supporting Documentation:

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Increasing Level and Duration of Stress

	Sedimentation	Turbidity
STRESS		
Photo-physiological stress	• Reduced photosynthetic efficiency of zooxanthellae and autotrophic nutrition to coral	• Reduced photosynthetic efficiency of zooxanthellae and autotrophic nutrition to coral
Changes in polyp activity	• Extrusion of mesenterial filaments following severe stress • Increased ciliary or polyp activity, and tissue expansion in some species to remove sediment	• Extrusion of mesenterial filaments following severe stress • Increased ciliary or polyp activity to feed
Mucus production	• Mucus production or sheeting to remove sediment	• Evidence of mucus production
SEVERE STRESS		
Sediment accumulation	• Accumulation of sediment on tissue of susceptible growth forms due to failure of mechanisms of rejection	
Change in coral colour	• Change in coral colour arising from changes in the density of zooxanthellae and photosynthetic pigments • Paling of coral due to partial bleaching	• Change in coral colour arising from changes in the density of zooxanthellae and photosynthetic pigments • Darkening of coral in response to reduced light due to photoacclimation
Bleaching	• Considerable whitening of corals due to the expulsion of a large proportion of zooxanthellae from the colony	• Considerable whitening of corals due to the expulsion of a large proportion of zooxanthellae from the colony
PARTIAL MORTALITY		
	• Injury to coral tissue, loss of polyps and partial mortality of the colony • Decrease in (live) coral cover	• Injury to coral tissue, loss of polyps and partial mortality of the colony • Decrease in (live) coral cover
MORTALITY		
	• Mortality of small-sized colonies and partial mortality of large corals	
	• Mortality of susceptible species and size classes.	• Mortality of susceptible species and size classes.
	• Decreased density, diversity and coral cover	• Decreased density, diversity and coral cover
	• Changes in community structure	• Changes in community structure
	• Widespread mortality of corals	• Wide-spread mortality of corals
	• Major decreases in density, diversity and coral cover	• Major decreases in density, diversity and coral cover
	• Dramatic changes in community structure, and shifts towards the dominance of non-coral species, such as sponges and algae	• Dramatic changes in community structure, and shifts towards the dominance of non-coral species, such as sponges and algae

Figure 1: Response of corals to increasing levels and durations of sedimentation and turbidity (PIANC 2010).

EIS
SUB-APPENDIX D

NATURAL RESOURCE REPORTS

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

Appendix D

D-1

Baseline Report

Environmental Baseline Study and Impact Assessment for Port Everglades Harbor

Final Report

May 31, 2001

Prepared for:
Jacksonville District
U.S. Army Corps of Engineers
400 West Bay Street
Jacksonville, FL 32202

Prepared by:
Dial Cordy and Associates Inc.
490 Osceola Ave.
Jacksonville Beach, FL 32250

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1.0 INTRODUCTION

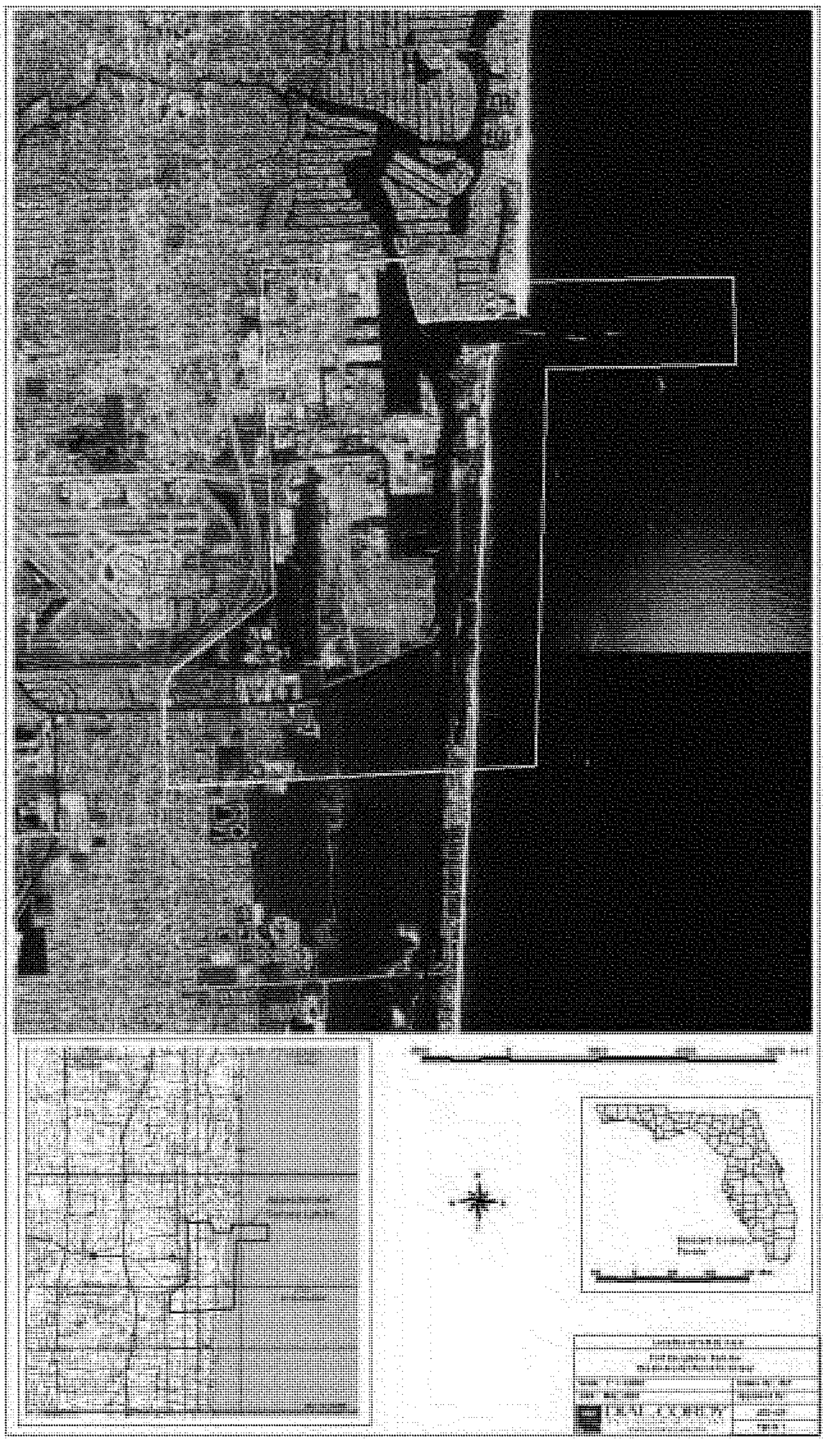
Dial Cordy and Associates Inc. (DC&A) was subcontracted by Gulf Engineers and Consultants, Inc. (GEC) to conduct an environmental baseline and impact assessment for proposed deepening and widening of Port Everglades, Broward County, FL for the U.S. Army Corps of Engineers, Jacksonville District, under contract No. DACW17-99-D-0043.

The environmental baseline survey and impact assessment included, the collection and review of literature and existing data, field investigations to characterize marine and terrestrial habitats within the areas to be potentially impacted, a compilation of this information and an assessment of impacts associated with deepening and widening activities to the resources identified. Data was collected in an initial seagrass survey in 1999 (DC&A 1999), terrestrial surveys and additional seagrass mapping in 2000, and an outer entrance channel integrated video mapping survey in May 2001. The data collected during this study and related composite resource maps are summarized in this report.

1.1 Background

Port Everglades Harbor Federal Navigation Channel is located in the southeastern section of Broward County, FL (Figure 1). Port Everglades was initially constructed in 1925-28. The development was funded by the cities of Hollywood and Fort Lauderdale and a private developer. The initial project consisted of an entrance channel, a turning basin, a slip, two bulkheads, two rock jetties, and two submerged breakwaters. The River and Harbor (R&H) Act of 1930 authorized Federal maintenance of the locally constructed entrance channel, turning basing and rock jetties. The non-Federal sponsor constructed the most recent modifications to Port waterways between 1984 through 1991. These modifications were phased using five separate construction contracts. The result of these improvments included deepening of the Southport Access Channel (SAC) from the Main Turining Basin (MTB) to the Dania Cutoff Canal (DCC) to a project depth of 42 feet, and construction of the Turning Notch (TN) to a depth of 42 feet. The present Port Everglades Federal Navigation Project provides for an Outer Entrance Channel (OEC) that is 45 feet deep and 500 feet wide, an Inner Entrance Channel (IEC) that is 450 feet wide and 42 foot deep, a Main Turning Basin (MTB) that is 42 feet deep, a North Turning Basin (NTB) that is 31 feet deep, a South Turning Basin that is (STB) 31 to 36 feet deep, a Southport Access Channel (SAC) that is 400 feet wide and 42 feet deep, and a Turning Notch (TN) that is 42 feet deep. This study also addressed the widening of the SAC across Berths 25 and 26. The Feasibility Study presently underway was authorized by a resolution of the House Committee on Transportation on May 9, 1996. The resolution reads, in part, as follows:

> "Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that, the Secretary of the Army is requested to review the reports of the Chief of Engineers on Port Everglades Harbor, Florida, published as House Document 126, 103rd Congress, 1st Session, and House Document 144, 93rd



Congress, 1st Session, and other pertinent reports to determine whether any modifications of the recommendations contained therein are advisable at the present time in the interest of navigation and related purposes, with particular reference to navigation into and within the part of the project known as the Southport Channel."

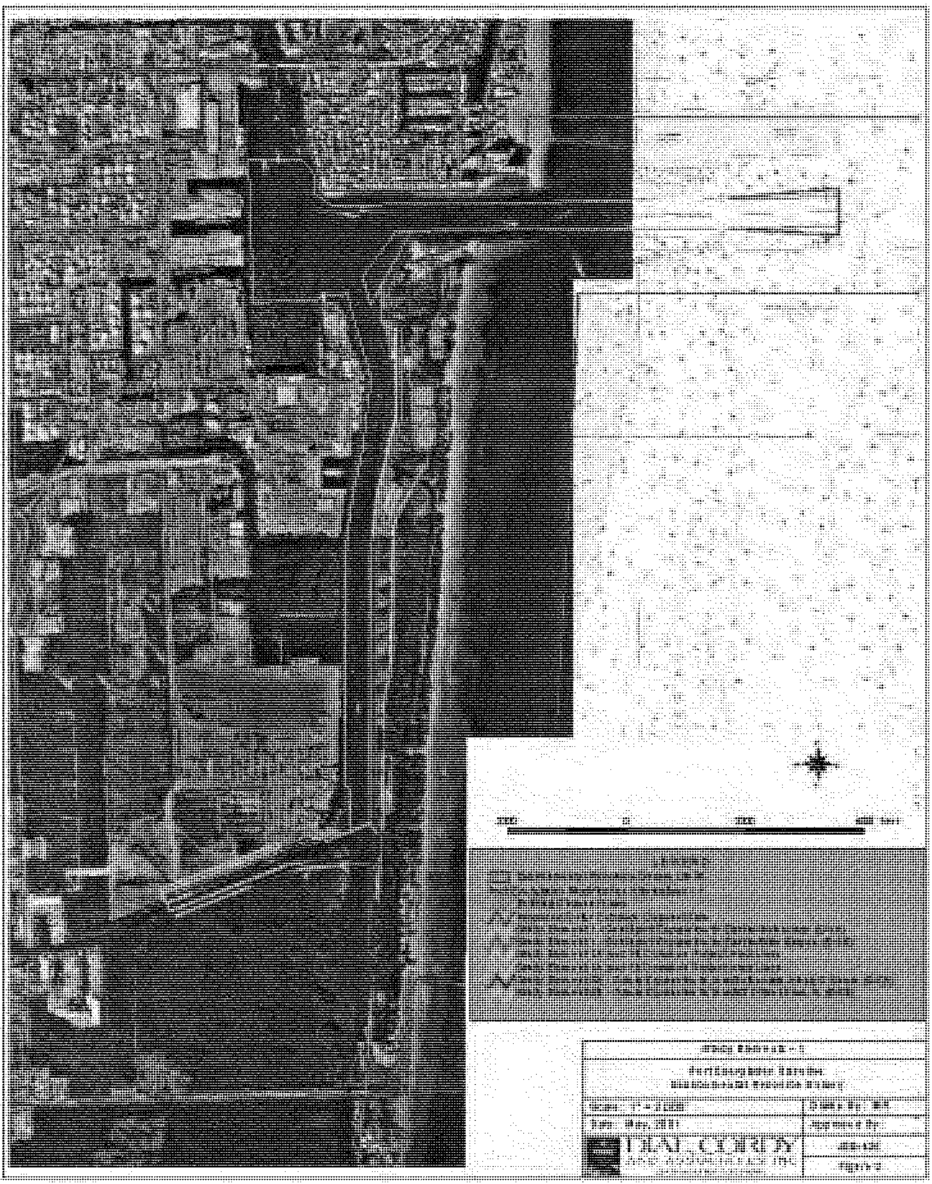
On June 29, 1999 the project was re-scoped based on future development plans. The re-scope included a modified study to address the future need to bring larger Post Panamax size vessels, and cruise ships such as the Royal Caribbean Eagle Class vessels into the Port.

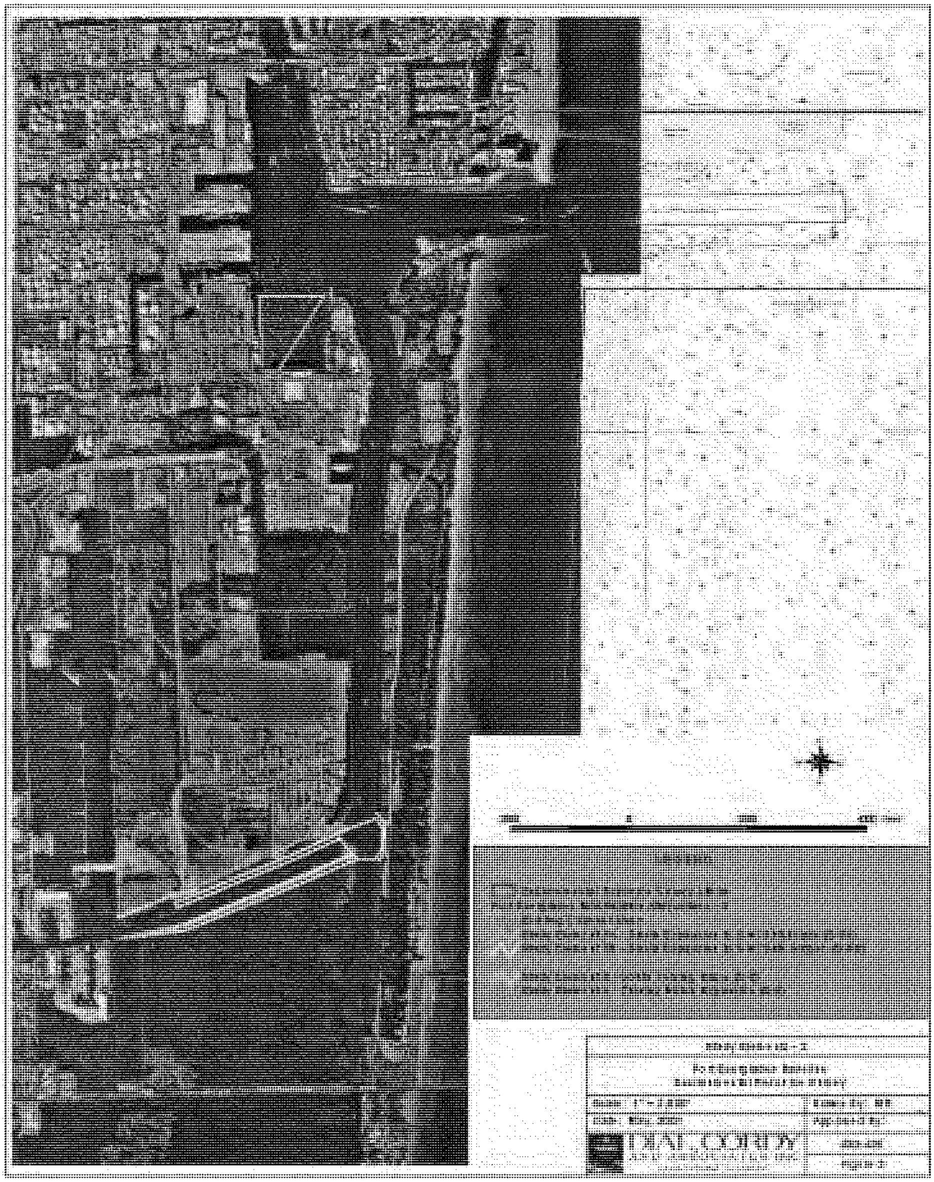
1.2 Proposed Study Element Descriptions

Proposed study elements can be seen in Figures 2 and 3. A description of the proposed alternatives is as follows:

No Action Plan	Port would continue operation under the existing conditions.
Alternative S-1A	Southport expansion to the east, to include deepening of AICW to a maximum of 58 feet and widening of the channel, with a bulkhead along eastern side of area. Also includes deepening Outer Entrance Channel (OIC), Inner Entrance Channel (IEC), Main Turning Basin (MTB) and removal of widener shoal.
Alternative S-1B	Southport expansion to the east, to include deepening of AICW to a maximum of 55 feet and widening of the channel, with a side slope along eastern side of area. Also includes deepening Outer Entrance Channel (OIC), Inner Entrance Channel (IEC), Main Turning Basin (MTB) and removal of widener shoal.
Alternative S-5A	Widening of the Dania Cutoff Canal to the north with an 80' offset to the south. Deepening of canal to a depth of 36'. On north side, construction of bulkhead, on the south side a bulkhead constructed in West Lake Park.
Alternative S-5B	Widening of the Dania Cutoff Canal to the north with an 80' offset to the south. Deepening of canal to a depth of 36'. On north side, construction of bulkhead, on the south side a sideslope constructed just north of West Lake Park.
Alternative S-6A	Widening of the Dania Cutoff Canal to the south. Deepening of canal to a depth of 36'. On north side, construction of bulkhead, on the south side a bulkhead constructed in West Lake Park.
Alternative S-6B	Widening of the Dania Cutoff Canal to the south. Deepening of canal to a depth of 36'. On north side, construction of bulkhead, on the south side a sideslope constructed just north of West Lake Park.
Alternative S-7	Deepen North Turning Basin to 55'.
Alternative S-8	Deepen South Turning Basin to 55'.
Alternative S-9	Expansion of the Turning Notch to the West and North.

The described study elements include consideration of four different disposal options for dredged material. Alternative descriptions with related disposal options will be discussed further in the impacts section.





2.0 TECHNICAL APPROACH

This section describes the technical approach used to collect and analyze data associated with the environmental baseline study. Resource surveys were conducted in late summer 1999, 2000 and in May 2001.

2.1 Terrestrial Resources

2.1.1 Existing Data Collection and Review

Prior to the commencement of field investigations, existing data regarding present and historic conditions of natural resources were assembled and reviewed. Once reviewed, the data were compiled into GIS resource files identifying probable current conditions, significant resources, and questionable areas. A list of sources contacted to obtain relevant data and corresponding natural resources information is located in Appendix A.

2.1.2 Field Verification and Mapping

Field surveys were conducted on 26-27 September 2000 to verify the preliminary resource maps and to identify any additional environmental constraints. Areas of potential jurisdictional wetlands were given particular attention with regard to hydrological, soil, and vegetative characteristics according to the *1987 Corps of Engineers Wetlands Delineation Manual* and the *Florida Wetlands Delineation Manual* (1995). Presence or absence of any indicators of state or federally protected flora and fauna or their habitat was also determined. A list of potential protected species for all of Broward County is included in Appendix B.

2.2 Marine Resource Survey

A description of methods utilized to document and characterize marine seagrass, hardbottom, and coral reef communities within the study area (Figure 1) are described below. Surveys were conducted on September 6-10, 1999 (DC&A 1999), September 19-21, 2000, and May 16-17, 2001.

2.2.1 Seagrass Community

Descriptions of methods used to assess seagrass communities within the Port area are included in this section.

2.2.1.1 Location of Survey Transects

The location of survey transects for the 1999 survey ranged from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC to Port Denison (Figure 4). For the 2000 survey, transects were located within the area 1000 feet south of the DCC on the east side of the channel, and on the west, from the DCC south to the Dania Beach Boulevard Bridge (Figure 4).

2.2.1.2 Seagrass Mapping

Marine seagrass distribution was mapped along each of the 62 transects by locating the end positions using Differential Global Positioning System (DGPS), laying a weighted line marked in one meter increments from the shore, and then conducting a visual diver survey along the weighted line to document seagrass distribution and occurrence from the shore to the edge of channel. Seagrass habitat and bottom type observed while crossing each transect were noted. Divers drift dove to the next transect, and if any seagrass was found between transects, a GPS position at the start and end of the grass bed was recorded, and the width of the grass bed estimated. Information recorded on seagrass habitat type and distribution was transferred from field logs and entered into a spreadsheet. Descriptions of habitat classifications are shown in Table 1. This approach allowed a visual representation of species' associations and occurrences across the shelf, channel, and slope as compared with bottom depth. Maps were produced for all stations surveyed that had seagrass present. A GIS map (ArcView) and database were created to illustrate seagrass distributions throughout the study area.

2.2.1.3 Seagrass Occurrence, Abundance, and Density

To obtain biological data regarding the location, occurrence, abundance, and density of marine seagrass, a SCUBA point intercept survey was performed along each transect. For each transect, the average percent (percent of sixteen 25 x 25 cm sub-units within a $1m^2$ quadrat that contains at least one seagrass shoot) was estimated in $1m^2$ quadrats at 10m intervals along the transect line (Virnstein 1995; Fonseca et al. 1998; Braun-Blanquet 1965). Specific data recorded within each $1m^2$ quadrat for each seagrass species present included the number of sub-units containing at least one shoot, an average cover abundance score (Braun-Blanquet 1965), a description of substrate type, and any other observations considered useful. The cover abundance scale is discussed below.

The cover abundance scale was computed beginning at the zero point and at 10m intervals along each transect. The content of each quadrat was visually inspected and a cover abundance scale value assigned to the seagrass coverage.

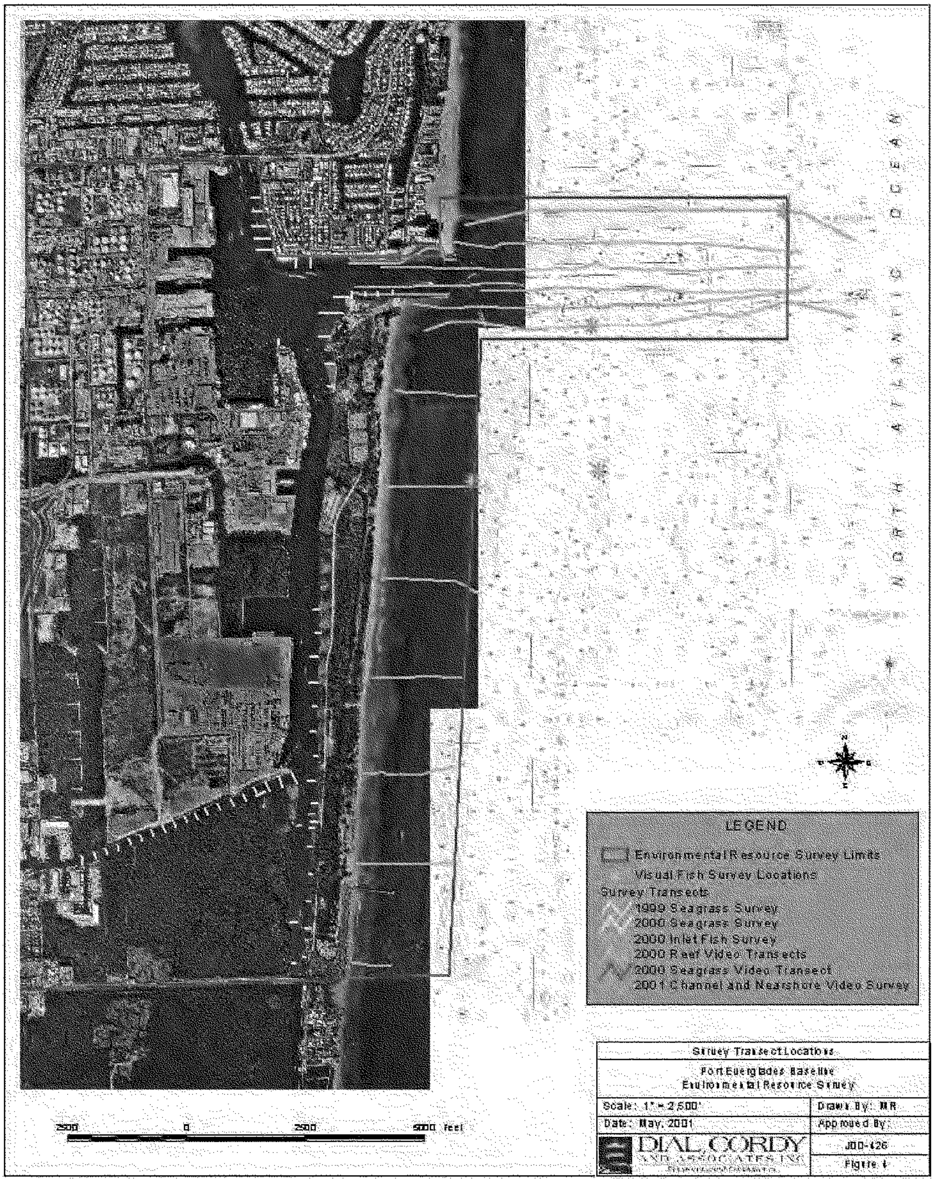

NORTH ATLANTIC OCEAN
LEGEND
Environmental Resource Survey Limits
Visual Fish Survey Locations
Survey Transects
1999 Seagrass Survey
2000 Seagrass Survey
2000 Inlet Fish Survey
2000 Reef Video Transects
2000 Seagrass Video Transect
2001 Channel and Nearshore Video Survey
2500 0 2500 5000 Feet
Survey Transect Locations
Port Everglades Baseline
Environmental Resource Survey
Scale: 1" = 2,500'
Drawn By: MR
Date: May, 2001
Approved By:
DIAL CORDY AND ASSOCIATES INC
JDD-426
Figure 4

Table 1 Habitat Classification System Used for Mapping of Seagrass Species

Habitat Types	Description
Halophila decipiens	Monospecific bed of this species
Halophila johnsonii	Monospecific bed of this species
Halodule wrightii	Monospecific bed of this species
Syringodium filiforme	Monospecific bed of this species
Mixed Submerged Aquatic Vegetation	*S. filiforme or H. wrightii* with *H. decipiens*
Mixed Submerged Aquatic Vegetation with *H. johnsonii*	*S. filiforme* and or *H. wrightii* with *H. johnsonii*
Mixed Submerged Aquatic Vegetation with *H. johnsonii* and *H. decipiens*	*H. wrightii* with both species of *Halophila*
Unvegetated Bottom	Sand, silt or shell substrate with no seagrass or live bottom, may have marine algae present
Live-Bottom Habitat	Sponge and soft coral community over thin veneer of silty-sand

The scale values are:

0.1 = Solitary shoots with small cover
0.5 = Few shoots with small cover
1.0 = Numerous shoots but less than 5% cover
2.0 = Any number of shoots but with 5-25% cover
3.0 = Any number of shoots but with 25-50% cover
4.0 = Any number of shoots but with 50-75% cover
5.0 = Any number of shoots but with >75% cover

From the survey of quadrats along each transect, frequency of occurrence, abundance, and density of seagrass was computed as follows:

Frequency of occurrence = Number of occupied sub-units/total number of sub-units
Abundance = Sum of cover scale values/number of occupied quadrats
Density = Sum of cover scale values/total number of quadrats

2.2.1.4 Analysis and Interpretation of Seagrass Data

Distribution of seagrass community types and their potential occurrence in an area were mapped for each transect from survey data. Frequency of occurrence, abundance, and density were calculated from the quadrat data based on Braun-Blanquet (1965) methodology.

2.2.2 Hardbottom and Reef Habitat Assessment

In the area offshore (from the jetty in the federal channel to 2,000 feet offshore and 500 feet north and south of the outer channel), a reef and hardbottom assessment was conducted to verify existing resource maps and to generally characterize the marine resources in the study area. To verify the accuracy of existing reef and hardbottom maps (USACE 1992), towed underwater video in conjunction with DGPS was used to record and mark the occurrence of hardbottom or reef habitats along six transects located within the survey area (500 feet north and south of federal channel) (Figure 4). Video and field data collected were used to assess the accuracy of existing maps of reef and nearshore hardbottom habitat types within the study area.

2.2.2.1 Habitat Characterization and Mapping

To illustrate the occurrence of reef and hardbottom habitat types within the study area existing resource maps of the area were compared to video data. To document the nearshore hardbottom communities off John U. Lloyd SRA, digitized aerial photographs were analyzed using a multi-spectral image analysis classification (ERDAS^{TM}). Brief ground truthing of the image analysis was performed on May 16 - 17, 2001 by using an integrated towed video system. Eight transects were surveyed from the shore to 2000 feet seaward. The classification system utilized for mapping is described in Table 2. Following compilation of habitat distribution in reef and hardbottom communities, data were transferred into a database for mapping purposes using ArcView (GIS). A visual representation of habitat types was constructed using these data and existing maps for the Port Everglades area.

2.2.2.2 Visual Fish Survey

A visual survey of fishes found within the Port Everglades federal channel, reef, and nearshore hardbottom communities was performed. Reef and hardbottom communities were chosen from stations where DGPS coordinates were taken in conjunction with towed video documentation of reef or hardbottom sightings. At reef and hardbottom areas, divers were deployed along a 50m transect and all dominant fish species observed were recorded, and relative abundance was gauged. Along both sides of the federal channel, divers conducted visual surveys from the turning basin to the end of the jetty. During the visual surveys, dominant species and relative abundances were recorded. Species lists were then compiled using existing reports and data collected.

2.2.2.3 Photodocumentation

Along each visual fish survey transect, both video and still photo documentation were used to characterize invertebrate and fish species that were present along each transect. Video was recorded along each side of the 50m transect while still photographs (Appendix C) were taken randomly along the length of each transect.

2.2.3 Essential Fish Habitat Identification

The comprehensive Fishery Management Plan prepared by the South Atlantic Fishery Management Council (SAFMC 1998) establishes mangrove, seagrass, and nearshore and offshore reefs as Essential Fish Habitat (EFH) for coral, coral reefs, live-bottom habitat, Snapper-Grouper Complex, red drum, penaeid shrimp, and coastal migratory pelagics. Furthermore, the plan establishes Essential Fish Habitat-Habitat Areas of Particular Concern (EFH-HAPC) within these areas for the spiny lobster (*Panulirus argus*), Snapper-Grouper Complex, and penaeid shrimp. Areas meeting the criteria of the management plan were identified within the study area and noted during the study.

Table 2 Classification System Used for Mapping of Hardbottom and Reef Habitats

Habitat Type	Description
Low -Relief Reef	Low profile stony coral, sponge, and gorgonian community
High-Relief Reef	High profile stony coral, sponge and gorgonian community
Scattered Rock and Rubble	Carbonate rock covered with algae, sponge or algae and sponge in sand
Sand	Softbottom habitats composed primarily of sand/sand with algae layer
Variable Hardbottom with Sand	Oolitic limestone layer covered with fine layer of sand
Scattered Hardbottom with Sand	Variable rock layers interspersed with areas of softbottom
Predominately Sand w/ isolated rock	Softbottom habitat with small areas of exposed rock

3.0 ENVIRONMENTAL BASELINE

This section describes the general habitat types found within the Port Everglades area. The results of the 1999 (Dial Cordy 1999), 2000, and 2001 surveys are summarized, with terrestrial and marine resources covered.

3.1 Terrestrial Resources

3.1.1 Land Use and Biotic Community Cover Types

Current land use and biotic community cover types were mapped according to the Florida Land Use Cover Classification System (FLUCCS) (1995). GIS files were obtained from the South Florida Water Management District (SFWMD) web site and converted to ArcView format for modification. Field surveys did not identify any discrepancies with existing conditions. Figure 5 presents the FLUCCS category map for the project area, and an index of applicable FLUCCS designations is located in Table 3.

The following sections provide descriptions for the FLUCCS categories within the project boundaries that are considered natural areas and are of resource value or otherwise of note.

3220 Coastal Scrub

This scrub category represents a conglomeration of species found in the coastal zone. A few of the more common components are saw palmetto (*Serenoa repens)*, sand live oak (*Quercus geminata)*, myrtle oak (*Q. myrtifolia*), yaupon (*Ilex vomitoria*), railroad vine (*Ipomoea pes-caprae*), sea oats (*Uniola paniculata*), sea purslane (*Sesuvium maritimum*), sea grape (*Cocoloba uvifera*), Spanish bayonet (*Yucca aloifolia*), and prickly pear (*Opuntia sp.*). This cover type is generally found in dune and white sand areas. The only coastal scrub habitat located within the project area is within the boundaries of John U. Lloyd State Recreation Area (SRA) and just south of the SRA along the same peninsula.

4220 Brazilian Pepper

Brazilian pepper (*Schinus terebinthifolius*) an exotic, pestilent, species is found on peninsular Florida from the Tampa area southward. Commonly found on disturbed sites, this native of Brazil is also an aggressive invader of Florida's natural plant communities. Communities of these small, shrub-like trees are often established along borrow pits, levees, dikes, and old disturbed fields. This land cover occurs in scattered locations throughout the project area, with large portions occurring just west of West Lake Park.

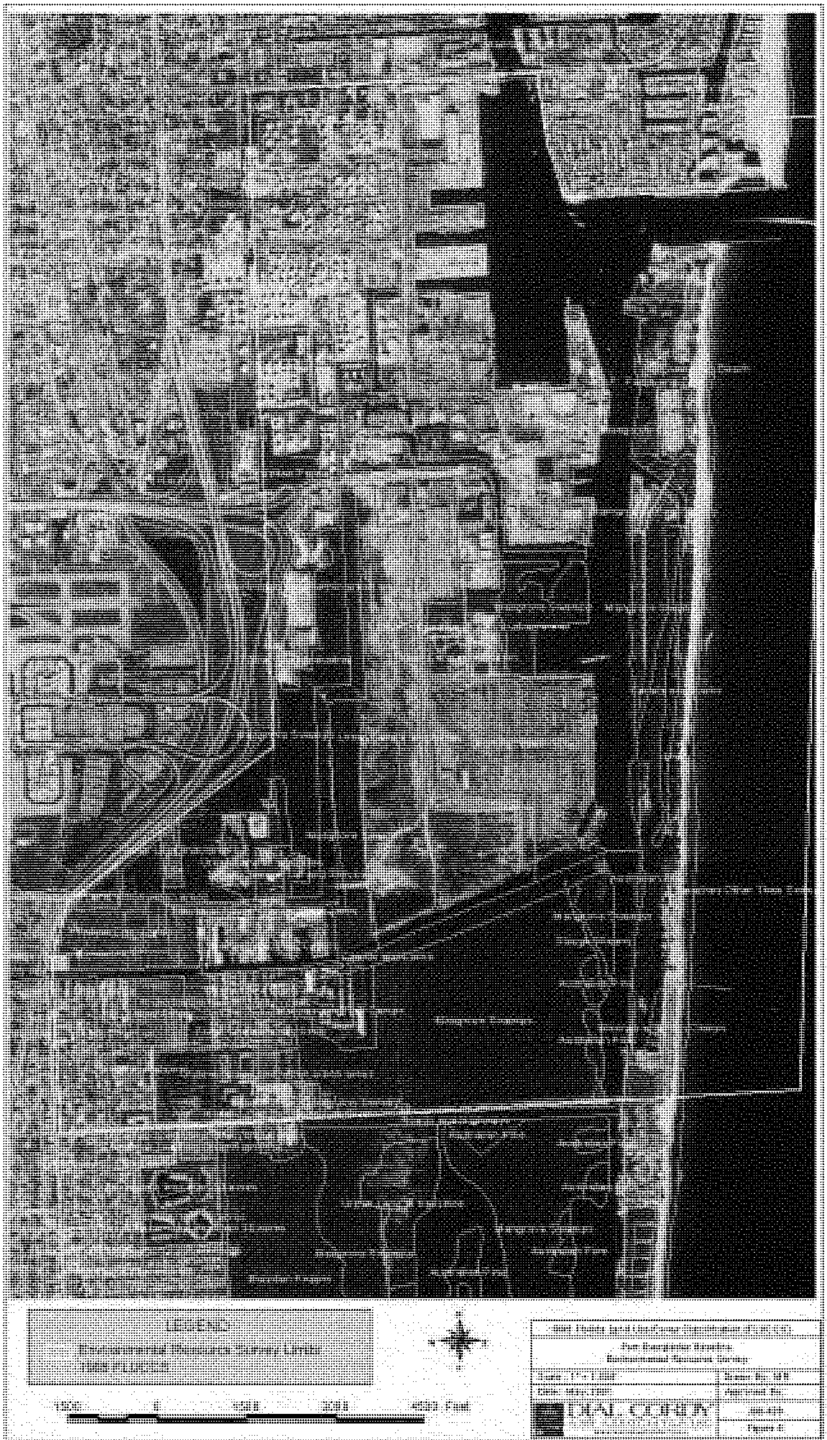


Table 3 Florida Land Use Cover Classification System Categories Within the Project Boundaries

1009	Mobile Home Units Any Density	2510	Horse Farms
1110	Residential, Low Density-Fixed Single Family Units	2610	Fallow Crop Land
1210	Residential, Medium Density-Fixed Single Family Units	3220	Coastal Scrub
1290	Residential, Medium Density-Under Construction	3290	Other Shrub and Brush
1310	Residential, High Density-Fixed Single Family Units	4220	Brazilian Pepper
1340	Residential, High Density-Multiple Dwelling Units, High Rise	4240	Melaleuca
1390	Residential, High Density-Under Construction	4340	Hardwood Conifer Mixed
1410	Retail Sales and Service	4370	Australian Pine
1411	Shopping Centers	4380	Mixed Hardwoods
1430	Professional Services	5100	Streams and Waterways
1450	Tourist Services	5220	Lakes >100 Acres-<500 Acres
1470	Mixed Commercial and Services	5330	Reservoirs >10 Acres-<100 Acres
1480	Cemeteries	5340	Reservoirs <10 Acres
1490	Commercial Services Under Construction	5600	Slough Waters
1550	Other Light Industrial	6120	Mangrove Swamps
1560	Other Heavy Industrial	6170	Mixed Hardwood Wetlands
1710	Educational Facilities	6172	Mixed Hardwood Wetlands-Mixed Shrubs
1720	Religious	6300	Wetland Mixed Forest
1730	Military	6412	Freshwater Marsh – Cattails
1810	Swimming Beach	6430	Wet Prairies
1820	Golf Courses	7100	Beaches Other Than Swimming Beaches
1840	Marinas and Fish Camps	7420	Borrow Areas
1850	Parks and Zoos	7430	Spoil Areas
1860	Community Recreational Facilities	8110	Airports
1870	Stadiums	8140	Roads and Highways
1890	Other Recreational	8150	Port Facilities
1910	Undeveloped Land with Urban Areas	8160	Canals and Locks
1920	Inactive Land with Street Pattern	8180	Auto Parking Facilities
1930	Urban Land in Transition	8310	Electrical Power Facilities
1940	Other Open Land	8320	Electrical Power Transmission Lines
2110	Improved Pastures	8330	Water Treatment Plants
2140	Row Crops	8340	Sewage Treatment
2430	Ornamentals		

4240 Melaleuca

Melaleuca (*Melaleuca quinquenervia*) an exotic tree species occurs in almost pure stands. It is an aggressive competitor; invading and often taking over a site, forming a dense, impenetrable stand. Melaleuca generally is an indicator of a disturbed site. The only melaleuca within the project boundary is located in the extreme northwest corner of the project area.

4370 Australian Pine

Contrary to its name, Australian pine (*Casuarina equisetifolia*) is actually a hardwood. Its name is derived from its needle-like leaves and its characteristic cone-shaped crown structure. Australian pine was introduced to south Florida from Australia and is colonizing northward to the Tampa Bay area. It is common on disturbed sites, forming dense thickets, and is frequently planted as wind breaks and soil stabilizers. Areas of Australian pine are located throughout the project area from John U. Lloyd SRA, along Dania Beach Boulevard in West Lake Park, and along both sides of the AIWW.

4380 Mixed Hardwoods

This is a hardwood community in which no single species or species group appears to achieve a 66% dominance of the canopy. This class of hardwoods includes any combination of large and small hardwood tree species, none of which can be identified as dominating the canopy. The only mixed hardwood within the project boundaries is a small area located at the northwest corner of the I-595 U.S. 1 intersection.

5600 Slough Waters

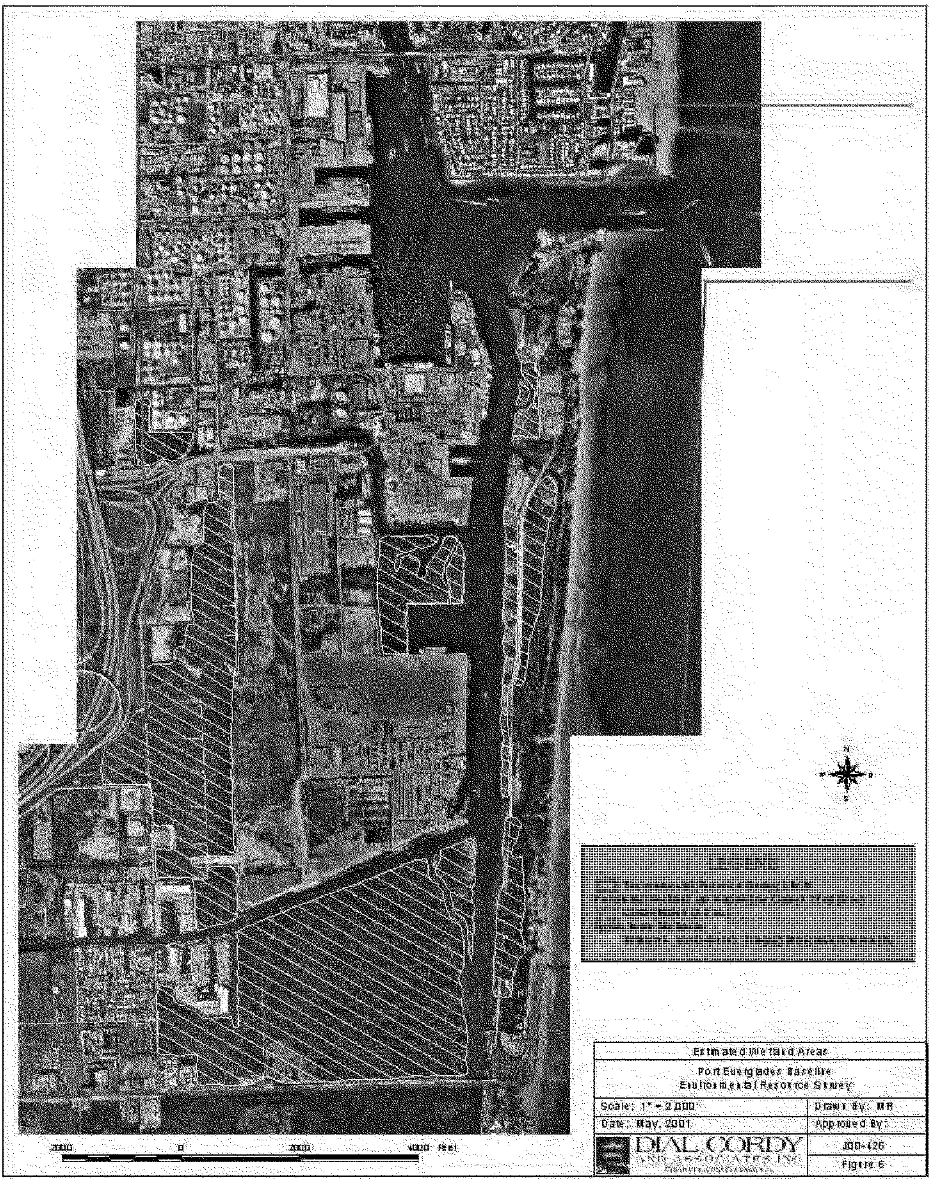
Sloughs are channels of slow moving water in the coastal marshland. The term also refers to "backwater sloughs," those narrow, often stagnant bodies of water found near inland rivers. Sloughs are located within John U. Lloyd SRA and West Lake Park.

6120 Mangrove Swamp (Fringing Mangrove Habitat)

This coastal hardwood community is composed of red (*Rhizophora mangle*) and/or black mangroves (*Avicennia germinans*), which is pure and predominant. The major associates include white mangrove (*Languncularia racemosa*), buttonwood (*Conocarpus erectus*), cabbage palm (*Sabal palmetto*), and sea grape. Fringing mangrove represent the largest natural habitat within the project boundaries (Figure 6). They occur along the western edge of John U. Lloyd SRA adjacent to the AIWW, on a section of the eastern edge of Port Everglades adjacent to the AIWW, south of Port Everglades within West Lake Park along the DCC, and extending northward from the DCC into the port property just south of Eller Drive. An isolated mangrove area is also located north of Eller Drive and east of U.S. 1.

6412 Freshwater Marshes-Cattail

This community is characterized by having cattail (*Typha* sp.) as the single dominant (greater than 66% cover) species. A single isolated freshwater cattail area approximately 3.2



Estimated Wetland Areas
Port Everglades Baseline
Environmental Resource Survey
Scale: 1" = 2,000'
Drawn By: MR
Date: May, 2001
Approved By:
DIAL CORDY
JDD-426
Figure 6
2000
0
2000
4000 Feet

acres in size, based on a wetland delineation performed (personal communication, Allan Sosnow, Port Everglades), occurs within the project boundaries (Figure 6). This area is highly disturbed and was most likely used as a disposal area for prior dredging projects, but has since reverted to a jurisdictional freshwater cattail marsh. This wetland is permitted for fill and as such will not be further considered in the impact assessment.

3.1.2 Jurisdictional Wetlands

Jurisdictional wetlands within the boundaries of the project occur as either fringing mangrove habitat, mixed wetland hardwoods, or cattail marsh and are displayed graphically in Figure 6. Descriptions of the jurisdictional wetland areas are provided below.

Fringing Mangrove Habitat

The majority of the jurisdictional wetlands within the project boundaries occur as fringing mangrove habitat. As described in the previous section, red and/or black mangroves, with a number of associated species, dominate this community type. The mangrove community is important for shoreline protection and stabilization in addition to supporting an abundance of marine species.

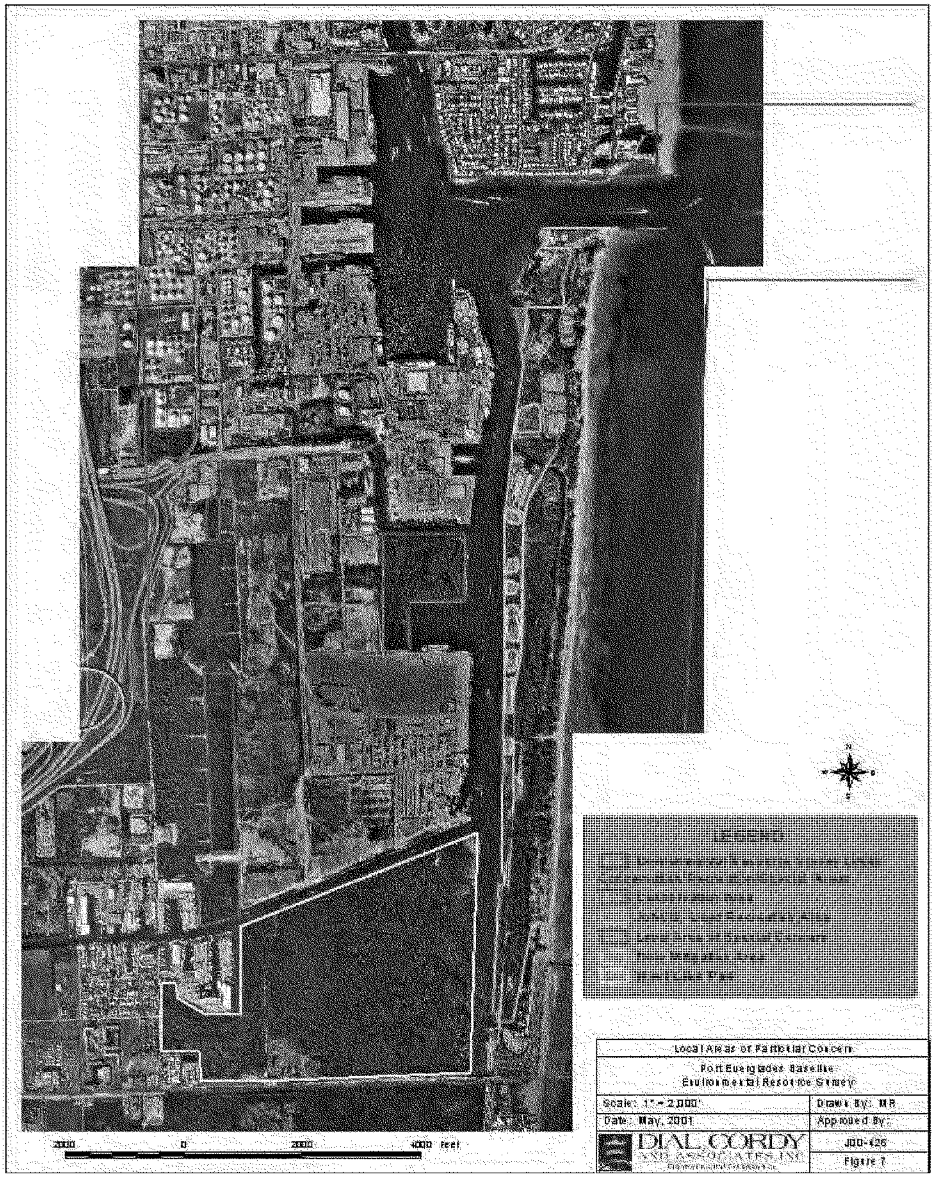
Fringing mangrove areas are designated in Figure 6. They occur along the western edge of John U. Lloyd SRA adjacent to the AIWW, on a section of the eastern edge of Port Everglades adjacent to the AIWW, south of Port Everglades within West Lake Park along the DCC, and extending northward from the DCC into the port property just south of Eller Drive. An isolated mangrove area is also located north of Eller Drive and east of U.S. 1. Fringing mangrove habitat along the western side of the AICW is comprised of habitat created by the port as mitigation for previously permitted impacts and native areas of mangrove.

Freshwater Marshes-Cattail

A single isolated freshwater cattail area approximately 3.2 acres in size occurs within the boundary of the project area. This area is highly disturbed and was most likely used as a disposal area for prior dredging projects, but has since reverted to a jurisdictional freshwater cattail marsh. This area is already permitted for construction.

3.1.3 Local Areas of Particular Concern

A number of areas currently exist within the project boundaries that require special consideration with regard to natural resources (Figure 7). John U. Lloyd SRA is comprised of 310 acres and lies just east of the AIWW and east of the port. The area is managed by the Florida Division of Recreation and Parks, and has provided recreational opportunities for the public since 1974. Many of the community types within the area are native communities and are highly valued by the resource agencies and the public.


LEGEND
Local Areas of Particular Concern
Port Everglades Baseline
Environmental Resource Survey
Scale: 1" = 2,000'
Drawn By: MR
Date: May, 2001
Approved By:
DIAL CORDY
AND ASSOCIATES INC
Figure 7
2000
0
2000
4000 feet

West Lake Park is located immediately south of the port and the Dania Cutoff Canal. The 1,400-acre West Lake Park is the largest mangrove estuarine habitat remaining in Broward County. The Broward County Board of County Commissioners is the lead agency in managing West Lake Park through a sublease from the Division of Recreation and Parks.

Within the Port Everglades limits, there are a number of areas designated as Previous Mitigated Areas. These mangrove areas are mitigation for previous wetland impacts associated with the Turning Notch Project in the mid-1990s. An additional 23 acres of mangroves were planted along the eastern edge of the AIWW at John U. Lloyd SRA for mitigation associated with the Turning Notch Project, however they were not placed under a conservation easement, as they were on state owned land.

3.2 Marine Resources

This section includes a description and review of the results of the marine resources survey. It outlines the findings of the seagrass community survey, including species occurrence, abundance and density. It also addresses reef and hardbottom community distributions, species profiles and the presence of Essential Fish Habitat (EFH). A summary of field data from 2000 and 2001 is located in Appendix D.

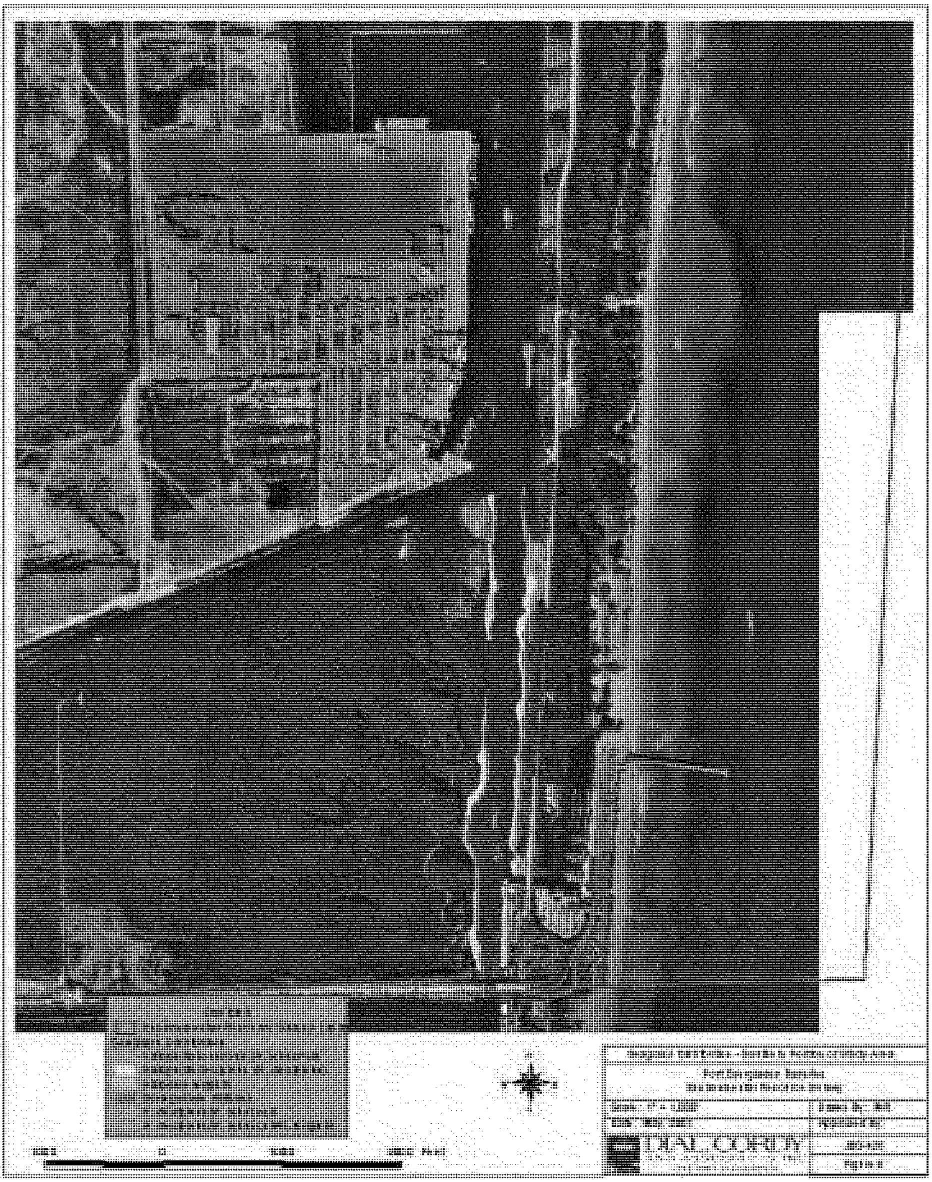
3.2.1 Seagrass Communities

Seagrass habitat cover type, abundance, and density for the study area are described below. Distribution and occurrence observations for the 1999 survey range from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC to Port Denison (Figure 8) (DC&A 1999). In the 2000 survey, transects were located within the area 1000 feet south of the DCC on the east side of the channel, and on the west, from the DCC south to the Dania Beach Boulevard Bridge to the east shore to the side of the channel 1000 feet south of DCC, and from the side of the channel to the west shore from the DCC south (Figure 9). To field verify whether seagrass occurred in the OEC, as reported by the DPEP staff (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County), an integrated video survey was performed within the federal channel (Figure 8).

3.2.1.1 Seagrass Species Frequency of Occurrence, Abundance, and Density

<u>General Occurrence</u>

Marine seagrass species observed within the study area included *Halodule wrightii, Halophila decipiens,* and *Halophila johnsonii.* Of the 62 transects surveyed in 1999 and 2000 (Figure 4),



marine seagrass species were observed at 28 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 4. DPEP divers documented the occurrence of *H. decipiens* within the OEC (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County)). Video surveys within the channel confirmed the presence of isolated patchy beds of *H. decipiens* in 45 feet of water.

Seagrass occurrence within the interior areas consisted of mixed Submerged Aquatic Vegetation (SAV) with *H. decipiens* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens*.

<u>Frequency of Occurrence</u>

H. johnsonii

H. johnsonii occurred within 14 of the 62 transects sampled. Frequency of occurrence values ranged from 0 to 25% with a mean of 11%.

Other species

Halophila decipiens occurred within 20 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 67% with a mean of 12%. In comparison, *H. wrightii* had a range of occurrence values between 0 to 24% with a mean of 8% over the study area.

<u>Abundance</u>

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover

H. johnsonii

Abundance values for *H. johnsonii* ranged from 0 to 4 for transects sampled. The average abundance for *H. johnsonii* in the Port Everglades area surveyed was 1.1 (< 5% cover). *H. johnsonii* had the highest abundance values of all species over all transects.

Other Species

Cover abundance for *H. wrightii* was low as it only occurred in 8 of the 62 transects sampled. The abundance values ranged from 0.1 to 1.5 with a mean 0.34. *H. decipiens* however, had values for cover abundance in the 0.1 to 5.0 range with a mean of 0.65.

Table 4 Seagrass Frequency of Occurrence, Abundance, and Density Values for Port Everglades Survey Transects for 1999-2000 Survey

		Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii
Transect		Frequency of Occurrence			Abundance			Density		
PE99-1	Total		0.0938			0.1000			0.0094	
PE99-2	Total		0.3438			0.1140			0.0391	
PE99-3	Total		0.0156			0.1000			0.0016	
PE99-6	Total		0.0750	0.1375		0.1000	0.1910		0.0075	0.0263
PE99-7	Total			0.1750			0.0790			0.0138
PE99-8	Total		0.0781	0.0469		0.1000	0.0330		0.0078	0.0016
PE99-10	Total		0.0357			0.0250			0.0009	
PE99-12	Total		0.0313	0.1458		0.1000	0.1860		0.0031	0.0271
PE99-13	Total	0.2250		0.1750	0.1110		0.1430	0.0250		0.0250
PE99-14	Total	0.0156	0.0625	0.0313	0.0500	0.0630	0.0500	0.0008	0.0039	0.0016
PE99-15	Total		0.0104	0.0208		0.1000	0.0500		0.0010	0.0010
PE99-17	Total			0.1458			0.1430			0.0208
PE99-24	Total	0.1250			0.1250			0.0156		
PE99-25	Total	0.0625			0.0500			0.0031		
PE99-32	Total			0.2250			0.1940			0.0436
PE99-34	Total			0.2500			0.1590			0.0398
PE99-35	Total			0.0125			0.1000			0.0013
PE99-36	Total		0.0078			0.1000			0.0008	
DCOC-16	Total		0.0313			0.1000			0.0031	
PE00-1	Total		0.4844	0.2500		0.0970	0.2500		0.0469	0.0600
PE00-2	Total	0.2411	0.6696		0.0930	0.2270		0.0223	0.1518	
PE00-3	Total		0.1719			0.1520			0.1563	
PE00-4	Total		0.5000			0.3130			0.1563	
PE00-5	Total	0.0469	0.2031	0.0156	0.1000	0.1540	0.1880	0.0469	0.0313	0.0469
PE00-6	Total		0.3906			0.2000			0.0781	
PE00-7	Total		0.2083			0.1000			0.0208	
PE00-8	Total	0.0313	0.0313		0.2500	0.5000		0.0078	0.0156	
PE00-9	Total	0.1667	0.4896	0.1354	0.2500	0.1360	0.2080	0.1667	0.0677	0.0417

Density

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values are very low compared to abundance because values are averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for this species was the highest of all species in the study area, with values not exceeding an average value of 0.3242 per meter squared. The range of density values for *H. johnsonii* was 0 to 1.0.

Other Species

Halophila decipiens had the second highest density values encountered, with a range of 0.0125 to 2.5 with an average of 0.3193. *H. wrightii* had the lowest densities of the three species with values ranging from 0 to 0.75 with a mean of 0.1519.

3.2.1.2 Associated Marine Plants and Animals

Seagrass communities provide important habitat for many different species of flora and fauna. In particular, the seagrass communities of southeastern Florida have a host of other flora that live within the seagrass community. These include, but are not limited to, algae of the genera *Halimeda, Udotea,* and *Penicllus* (Zieman 1982). Many invertebrate species also utilize seagrass communities. The most obvious inhabitants include the queen conch (*Strombus gigas*), urchins including the long spine urchin (*Diadema antillarum*), nudibranchs, bivalve mollusks, and crustaceans including the spiny lobster (*Panularis argus*), and the blue crab (*Callinectes sapidus*). On shallow seagrass areas corals and sponges may also occur (Zieman 1982). Many fish species have also been shown to have life cycles dependent on seagrass beds. Of particular importance are the mullet (*Mugil cephalus*), snook (*Centropomis undecimalis*), and many prey species including mojarras and pinfish. Seagrass beds are also important nurseries for many of the fish associated with SAFMS Snapper-Grouper Complex (SAFMC 1998).

3.2.2 Hardbottom and Reef Communities

This section outlines the hardbottom and reef communities located offshore of John U. Lloyd SRA and the study area north, south and within the Outer Entrance Channel.

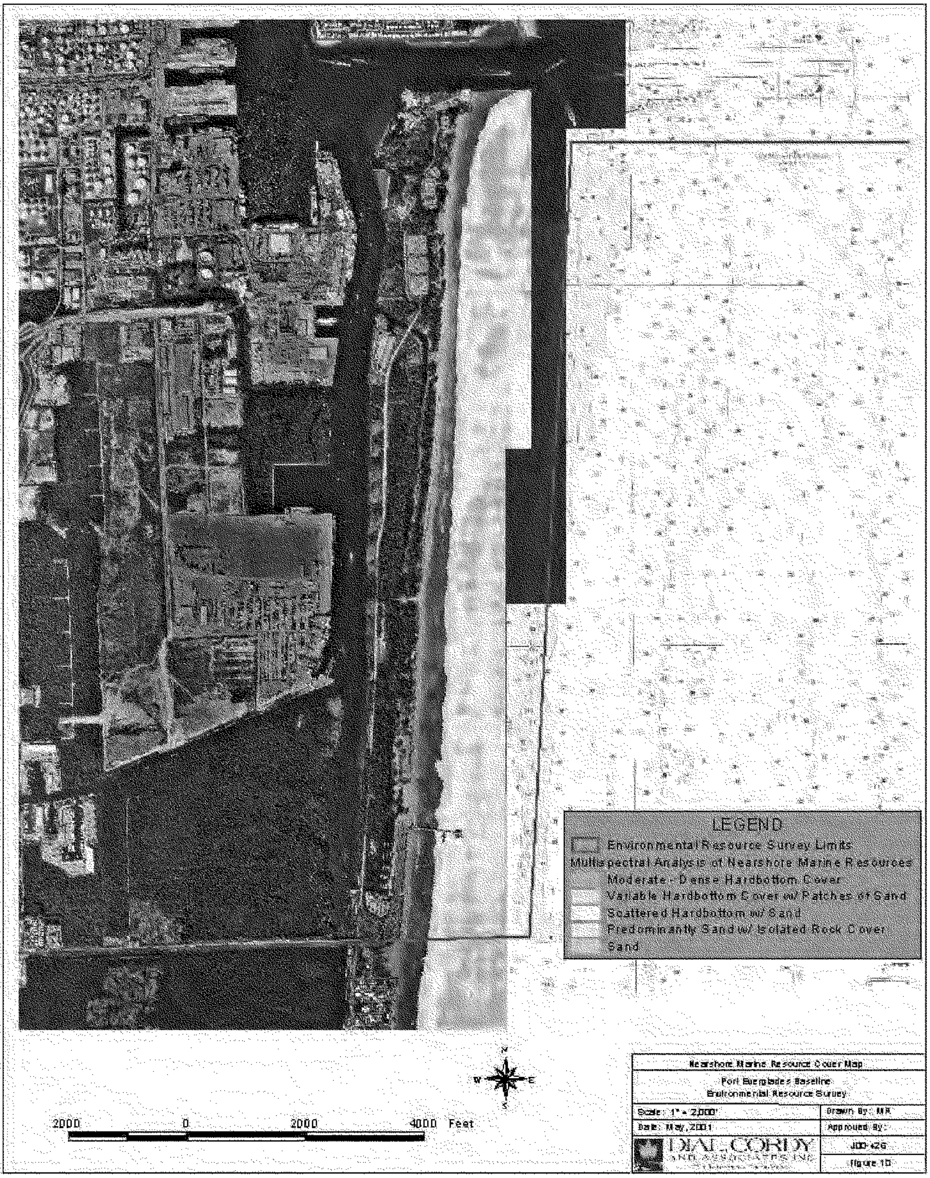
3.2.2.1 Hardbottom and Reef Distribution

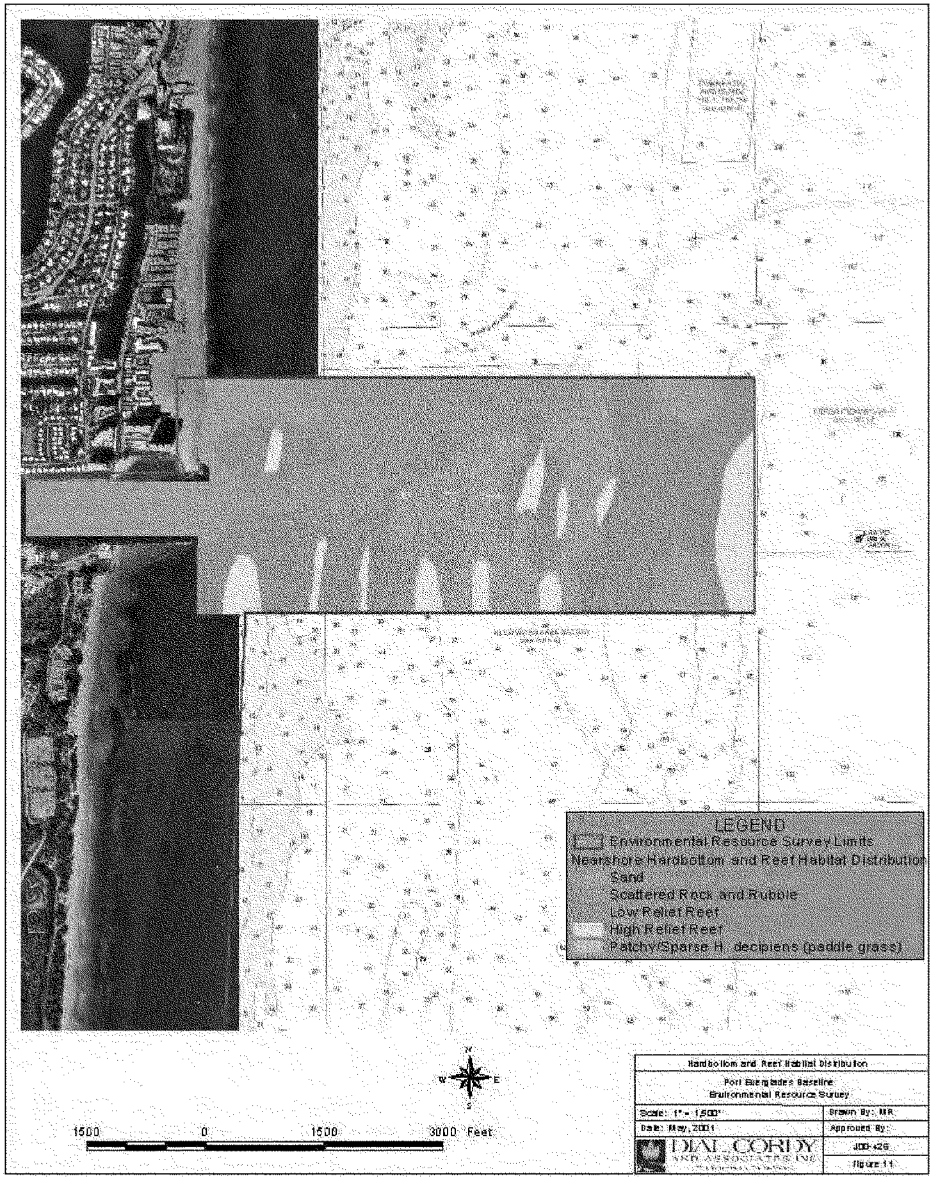
The nearshore hardbottom communities typically occur in 0 to 10 feet of water and exist in a physically stressed environment. This hardbottom area is part of the Miami Oolite Formation of Broward and Dade Counties (Hoffmeister et al. 1967). Hardbottom areas in Broward County run inside the nearshore reef tract, and are exposed where wave action has exposed the oolite formations. Nearshore hardbottom areas offshore of John U. Lloyd SRA has been characterized using multi-spectral image analysis classification. The resulting classification is shown in Figure 10. Ground truthing of these nearshore hardbottom areas was performed on May 16-17, 2001. These hardbottom areas are comprised of exposed rock with a fine covering of sand. These oolitic limestone formations are covered with communities dominated by algae and sponges with interspersed gorgonians and hard corals.

Seaward of the nearshore hardbottom area there are three separate parallel reef tracts. The first reef occurs from approximately 100 to 2000 feet from shore; the second reef is located 3,000 to 6,000 feet offshore; and the third reef is approximately 8,000 feet or more offshore (USACE 1996). There is an extensive sand area located between the second and third reef lines (USACE 1996). The area between the first and second reef lines in characterized by small isolated hermatypic coral heads and interspersed coral rubble, with areas of open sand.

The Coast of Florida Study (USACE 1992) maps show reef resources located within the entrance channel and adjacent areas. Transects swum by divers from DPEP Marine Resources Division indicate that no reef is located in the channel in this area, rather the area consists of scattered hardbottom consisting of rock outcroppings (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County). Early mapping efforts associated with this study showed the previous resource maps are skewed an unknown amount and that they should not be considered reliable. A more thorough mapping of the marine resources within the Entrance Channel and the surrounding area was conducted on May 16-17, 2001 to clearly define the type and quality of habitat present.

Based on the integrated video mapping survey conducted in May 2001, marine resources in the study area were reclassified and a resource mosaic prepared (Figure 11). Resources within the OEC included sand, low-relief reef, high relief reef, scattered rock/rubble, and patchy sparse *H. decipiens*. The area of low-relief hardbottom in water greater than 42 feet is a viable community with both gorgonians and hard corals present. This habitat is not of the same quality as areas of hardbottom outside of the channel due to the disturbed nature of the area. This area of low-relief hardbottom is rock exposed from prior dredging events and re-colonized after dredging. This community is comprised mostly of fast colonizing species such as sponges (e.g. *Ircinia* sp., *Niphates* sp., *Cliona* sp., and *Iotrochota* sp.) and gorgonians (e.g. *Eunicea* sp., *Plexaura* sp. and *Pseudopterogorgia* sp) and these communities can be expected to colonize these areas after any future dredging events.


LEGEND
Environmental Resource Survey Limits
Multispectral Analysis of Nearshore Marine Resources
Moderate - Dense Hardbottom Cover
Variable Hardbottom Cover w/ Patches of Sand
Scattered Hardbottom w/ Sand
Predominantly Sand w/ Isolated Rock Cover
Sand
N
W
E
S
2000
0
2000
4000
Feet
Nearshore Marine Resource Cover Map
Port Everglades Baseline
Environmental Resource Survey
Scale: 1" = 2,000'
Date: May, 2001
Drawn By: MR
Approved By:
DIAL CORDY
AND ASSOCIATES INC
Figure 10


LEGEND
Environmental Resource Survey Limits
Nearshore Hardbottom and Reef Habitat Distribution
Sand
Scattered Rock and Rubble
Low Relief Reef
High Relief Reef
Patchy/Sparse H. decipiens (paddle grass)
N
W
E
S
1500
0
1500
3000 Feet
Hardbottom and Reef Habitat Distribution
Port Everglades Baseline
Environmental Resource Survey
Scale: 1" = 1,500'
Drawn By: MR
Date: May, 2001
Approved By:
DIAL CORDY
AND ASSOCIATES INC
J00-426
Figure 11

3.2.2.1.1 Algae and Invertebrates Associated with Hardbottom and Reef Habitats

Live hardbottom and reef communities located in the study area have a great deal of diversity in the numbers of species present. These hardbottom communities have been characterized many times in the past (Dodge 1991; Seaman 1985; Britt 1977). The nearshore hardbottom occurs typically in 0 to 10 feet of water and is exposed to wave action, sediment transport, and varied water clarity. This habitat is very ephemeral in nature and the species associated with this habitat must be able to quickly recover from the stresses imposed by the environmental conditions. The dominant algae associated with these communities are in the genera *Caulerpa* sp., *Jania* sp., *Laurencia* sp., *Dictyota* sp. and *Halimeda* sp. (Dodge 1991, Vare 1991). Also associated with this nearshore hardbottom are algal mat species of the genus *Cladophora* sp., *Chaetomorpha* sp., and *Gelidiopsis* sp. (USACE 2000). The rock outcrops in this area tend to be covered with sponges of the genera *Ircinia* sp., *Niphates* sp., *Cliona* sp., and *Iotrochota* sp. Interspersed among these sponges are colonial anemones (*Zoanthus* sp.), and hydrocorals (*Millepora alcicornis*). This habitat often provides suitable habitat for a variety of other invertebrate species. (USACE 2000)

The most dominant feature of the reef communities near Port Everglades is the high density of gorgonians. These gorgonian corals are primarily of the genus *Eunicea* sp., *Plexaura* sp. and *Pseudopterogorgia* sp. Hard coral species also make up a significant part of the reef assemblages in this area and include *Porites asteroides, Diploria clivosa, Siderastrea siderea,* and *Montastrea cavernosa* (Britt 1977; Dodge 1991; Vare 1991). Representative photographs of the reef tracts from the reef surveys and video surveys are shown in Appendix C. The three distinct reef tracts offshore of Broward County are consistent with the overall assemblage of stony corals, sponges, and gorgonians found throughout Dade, Broward, and Palm Beach Counties (USACE 2000).

3.2.2.1.2 Visual Fish Survey

A visual fish survey at nearshore hardbottom and offshore reef sites was conducted along transects within the jetty of the entrance channel, hardbottom and offshore sites. The results of these surveys are shown in Table 5. Fish species encountered within the entrance channel to Port Everglades consisted primarily of members of the Family Pomacentridae (damselfishes) and Labridae (wrasses). Also abundant were juvenile Haemulid (grunt) and Lutjanid (snapper) species. These fishes, particularly the Lutjanid species, are important due to their potential recreational and commercial value and are included in the SAFMC Snapper-Grouper Complex. In total over 22 species of fish were recorded within the jetty of the entrance channel.

The nearshore hardbottom area had only 10 species of fish observed, the least of the habitats sampled. Once again the Labrids and Pomacentrids were the dominant species present, while Scarids (parrotfishes) and Acanthurids (surgeonfishes) were also commonly seen. Within this habitat, the yellowtail snapper (*Ocyurus chysurus*) was also observed. Other species of fish

Table 5 Relative Abundance of Fish Species Observed During Visual Survey Port Everglades, Florida

Common Name	Scientific Name	Channel	Hard Bottom	Offshore Reef
Bluehead Wrasse	Thalassoma bifasciatum	A	C	C
Slippery Dick	Halichores bivittatus	A	C	C
Yellowhead Wrasse	Halichoeres garnoti	-	-	C
Sergeant Major	Abudefduf saxailis	A	C	-
Cocoa Damselfish	Pomacentrus variabilis	A	C	A
Beaugregory	Pomacentrus partitus	A	-	A
Dusky Damselfish	Pomacentrus fuscus	C	-	C
Bar Jack	Caranx ruber	O	-	O
Princess parrotfish	Scarus guacamaia	O	C	O
Stoplight parrotfish	Sparisoma viride	O	C	O
Spottail Pinfish	Diplodus holbrooki	C	-	-
Hairy Blenny	Labrisomus nuchipinnis	R	-	-
Highhat	Equetus acuminatus	R	-	-
Sheepshead	Archosargus probatocephalus	R	-	-
Ocean surgeon	Acanthurus bahianus	C	C	C
Blue Tang	Acanthurus coeruleus	C	C	C
Spanish Mackerel	Scomberomorus maculatus	-	-	O
Sharpnose Puffer	Canthigaster rostrata	R	-	R
Checkered Puffer	Sphoeroides tetudineus	R	-	-
Bermuda Chub	Kyphosus sectatrix	O	-	-
Green Moray	Gymnothorax funebris	R	-	-
Purplemouth Moray	Gymnothorax vicinus	-	-	R
French Angelfish	Pomacanthus paru	O	-	O
Grey Angelfish	Pomacanthus arcuatus	O	-	O
Queen Angelfish	Holocanthus ciliaris	O	-	O
Rock Beauty	Holocanthus tricolor	-	-	O
Reef Butterflyfish	Chaetodon sedentarius	-	-	O
Foureye Butterflyfish	Chaetodon capistratus	-	-	O
Spotfin Butterflyfish	Chaetodon ocellatus	-	-	O
Porkfish	Anisotremus virginicus	-	-	O
Tobaccofish	Serranus tabacarius	-	-	O
Harlequin Bass	Serranus tigrinus	-	-	O
Hogfish	Lachnolaimus maximus	-	-	O
Red Grouper	Epinephelus morio	-	-	O
Bluestripe Grunt	Haemulon sciurus	-	-	O
French Grunt	Haemulon f lavolineatum	-	-	O
Juvenile Grunts	Haemulon spp	A	-	-
Juvenile Snapper	Lutjanus spp	A	-	-
Yellowtail Snapper	Ocyurus chysurus	-	O	O
Hamlet	Hypoplectrus unicolor	-	-	O
Scrawled Cowfish	Lactophyrus quadricornis	-	-	O
Gray Triggerfish	Balistes capriscus	-	-	O
Blenny	Malacoctenus spp.	-	O	O
Yellow Stingray	Urolophus jamaicensis	-	-	O
Yellowhead Jawfish	Opistognathus aurifrons	-	-	R
Spotted Goatfish	Pseudopeneus maculatus	-	-	O

that use this nearshore hardbottom area include bar jacks (*Caranx ruber*), hogfish (*Lachnolaimus maximus*), and porkfish (*Anistroremus virginicus*), as well as many others (Coastal Systems International 1997).

The offshore coral reef areas observed had the highest number of fishes encountered, with 36 species observed. Once again the most abundant species encountered were wrasses and damselfish. The bluehead wrasse (*Thalasomma bifasciatum*), cocoa damselfish (*Pomacentrus variabilis*) and the beaugregory damsel (*Pomacentrus partitus*) were among the most common. This concurs with similar findings by Spieler (1998). Of particular interest, juvenile red grouper (*Epinephelus morio*), yellowtail snapper (*Ocyurus chysurus*), Spanish mackerel (*Scomberomorus maculatus*), and grunts (Haemulidae), were recorded within these offshore reef habitats. All of these species are listed in the SAFMC management plan (1998).

3.2.3 Unvegetated Bottom Communities

The shallow unvegetated communities of the AIWW and basins associated with Port Everglades have been extensively surveyed in relation to monitoring of past maintenance dredging within the port area. This area consists of softbottom benthic communities interspersed with rubble left from previous dredging activities. Messing and Dodge (1997) and Rudolph (1986) have identified as many as 370 species of invertebrates within the shallow water benthic community. The most consistent fauna within these communities consist of several taxa of polychaete worms, oligochaetes, mollusks, sipunculans, peracarid crustaceans, platyhelminthes, and nemertina (Messing and Dodge 1997, Rudolph 1986). All of these studies were conducted in shallower areas adjacent to the existing channel or turning basin, and reflect a more diverse and abundant benthic community than likely occurs in the deeper federal channel or waterways of the Port.

In offshore softbottom communities the most dominant organisms tend to be polychaete and nematode worms. Dodge (1991) found during an infaunal study offshore of Hollywood Beach that the dominant taxa were polychaetes (52%), nematodes (14%), and crustaceans (9%). Macroalgal growth is also associated with these communities with the most abundant species being from the green algae genera *Caulerpa* sp., *Halimeda* sp., and *Codium* sp. during the summer months. This is in contrast to the winter months where *Dictyota* sp. and *Sargassum* sp. are more common (USACE 1996). Invertebrate fauna also utilize this softbottom area and these can include the Florida fighting conch (*Strombus alatus*), milk conch (*Strombus costatus*), king helmet (*Cassia tuberosa*), and the queen helmet (*Cassia madagascariensis*) (USACE 1996). This area, since it lies within the second and third reef lines within the study area, may provide a corridor for reef species to travel between reef lines and also be an important foraging area for some fish species (Jones, et al. 1991).

3.2.4 Essential Fish Habitat

The SAFMC (1998) has designated that mangrove, seagrass, nearshore hardbottom, and offshore reef areas within the study area as EFH (Table 6). The nearshore bottom and offshore reef habitats of southeastern Florida have also been designated as EFH-HAPC (SAFMC 1998). Managed species that commonly inhabit the study area include Pink shrimp (*Penaeus duorarum*), and spiny lobster (*Panularis argus*). These shellfish utilize both the inshore and offshore habitats within the study area. Members of the 73 species Snapper-Grouper Complex that commonly use the inshore habitats for part of their life cycle include blue stripe grunts (*Haemulon sciurus*), French grunts (*Haemulon flavolineatum*), mahogany snapper (*Lutjanus mahogoni*), yellowtail snapper (*Ocyurus chysurus*), and red grouper (*Epinephelus morio*). These species utilize the inshore habitats as juveniles and sub-adults and as adults utilize the hardbottom and reef communities offshore. In the offshore habitats, the number of species within the Snapper-Grouper Complex that may be encountered increases. Other species of the Snapper-Grouper Complex commonly seen offshore in the study area include gray triggerfish (*Balistes capriscus*), and hogfish (*Lachnolaimus maximus*). Coastal migratory pelagic species also commonly utilize the offshore area adjacent to the study area. In particular, the king mackerel (*Scomberomorus cava*lla), and the Spanish mackerel (*Scomberomorus maculatus*) are the most common. As many as 60 corals can occur off the coast of Florida (SAFMC 1998) and all of these fall under the protection of the management plan.

3.3 Threatened and Endangered Species

A number of state and federally listed protected species occur in south Florida and Broward County. A list of protected flora and fauna for Broward County was obtained from the Florida Natural Areas Inventory (FNAI) and is included in Appendix B. Descriptions of terrestrial and marine protected species, which are known to occur within the study area, are provided in the following sections.

3.3.1 Terrestrial Species

Utilization of the terrestrial habitats within the project area by protected species is limited due to the highly urbanized nature of the region. Listed flora such as the golden leather fern (*Acrostichum aureum*) occur in the fringing areas of mangrove swamps and along various watercourses, while other listed plant species such as sea lavender (*Argusia gnaphalodes*) and beach peanut (*Okenia hypogaea*) occur in the dune areas and estuarine habitats on John U. Lloyd SRA. These plants are listed by the Florida Department of Agriculture, but have no federal status. Coordination with the state will not be required concerning these species.

A number of listed and migratory bird species utilize the area and surrounding waters for feeding, lofting, and roosting. A complete listing of these species is located in Appendix E. No other terrestrial listed species or their habitats were identified within the project boundaries.

Table 6 Essential Fish Habitat Areas in South Florida

Estuarine Areas (Dania Cut-Off Canal, AIWW, Inner Entrance Channel)	Estuarine Emergent Vegetation
	Estuarine shrub/scrub (mangrove)
	Seagrass
	Intertidal flats
	Estuarine Water Column
Marine Areas (Outer Entrance Channel, Nearshore and Off-shore areas)	Live/Hard Bottom
	Coral and Coral Reef
	Artificial Reefs
	Sargassum
	Water Column

Source: South Atlantic Fisheries Management Council, 1998

3.3.2 Marine Species

A description of the threatened and endangered marine species known to occur in the study area is outlined in this section. Distribution within the study area, and seasonal occurrences are discussed (Figure 12).

3.3.2.1 H. johnsonii

H. johnsonii was listed as a threatened species by NMFS on September 14, 1998 (63 FR 49035) and a re-proposal to designate critical habitat pursuant to Section 4 of the Endangered Species Act (ESA) was published on December 2, 1998 (64 FR 64231). The final rule for critical habitat designation for *H. johnsonii* was published 5 April 2000 (Federal Register, vol. 65, No. 66). *H. johnsonii* has one of the most limited geographic ranges of all seagrass species. It is only known to occur between Sebastian Inlet and northern Biscayne Bay on the east coast of Florida (Kenworthy 1997). As stated in earlier reports (DC&A 1999) and the findings of this survey, *H. johnsonii* occurs within the AIWW south of the turning basin for Port Everglades, in the DCC, and within the area considered for widening and deepening.

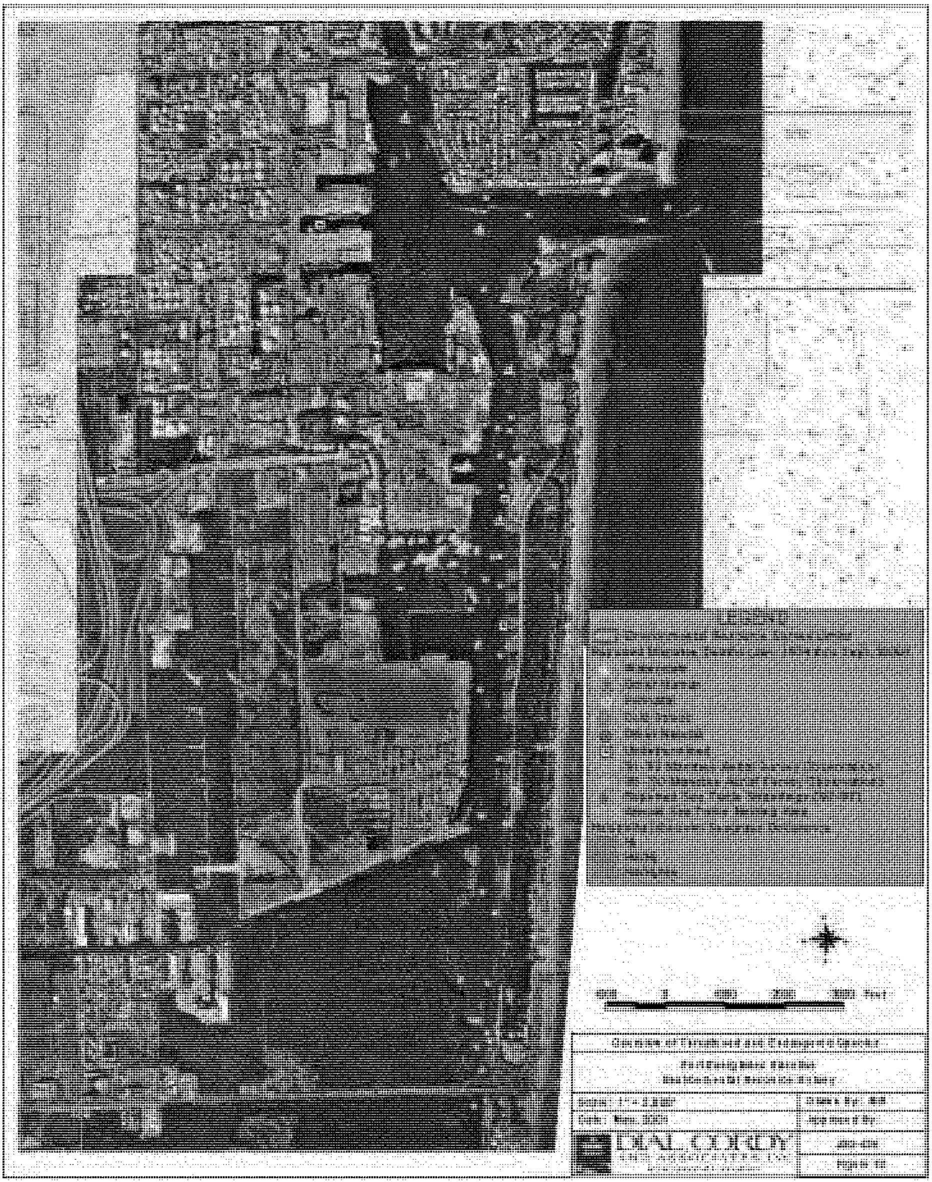
3.3.2.2 Manatee

The West Indian manatee (*Trichechus manatus*) has been listed as a protected mammal in Florida since 1893. Federal law under the Marine Mammal Protection Act of 1972 and the Endangered Species Act as amended in 1973 protects manatees. Florida provided further protection in 1978 by passing the Florida Marine Sanctuary Act designating the state as a manatee sanctuary and providing signage and speed zones in Florida's waterways.

Within Broward County there exists both a permanent and transient population of manatees. Surveys show that during the winter months when temperatures drop, manatees from the north Florida and also Dade County will migrate to the Florida Power and Light (FP&L) power plant at Port Everglades (Sirenia Project 2000). During cold weather as many as 234 manatees have been recorded at the Port Everglades plant at one time (Broward County 1992). During the summer months when the water warms, manatees return to the counties to the north and south to forage and reproduce, however, telemetry and aerial surveys confirm manatees are present within Broward County all year (Broward County 1992) (Sirenia Project, 2000) (Figure 12).

3.3.2.3 Sea Turtles

Broward County is within the normal nesting range of three species of sea turtles: the loggerhead (*Caretta caretta*), the green sea turtle (*Chelonia mydas*), and the leatherback (*Dermochelys coriacea*). The green sea turtle and leatherback sea turtle are both listed under


DIAL CORDY

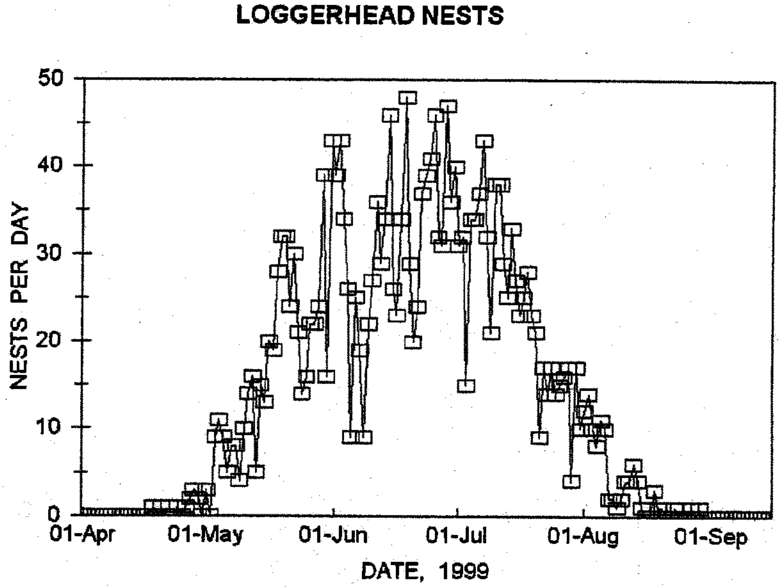
the U. S. Endangered Species Act, 1973 and Chapter 370, F.S. The loggerhead turtle is listed as a threatened species (Burney and Margolis 1999). Within the 38.6 miles of beach from the Palm Beach County line to the Dade County line a total of 2620 sea turtle nests were found in 1999 (Burney and Margolis 1999). From 1990 through 1999, an average of 2446 sea turtle nests were discovered on Broward County beaches. Within John U. Lloyd SRA a total of 212 sea turtle nests were observed during 1999. A summary of sea turtle nesting activity for John U. Lloyd SRA is found in Table 7. The majority of sea turtle nesting activity occurred during the summer months of June, July and August, with nesting activity occurring as early as March and as late as September (Burney and Margolis 1999) (Figure 13). Figure 14 represents the historical nesting success of turtles on Broward County beaches from 1991 though 1999. The waters offshore of Broward County are also habitat used for foraging and shelter for the three species listed above and possibly the hawksbill turtle (*Eretmochelys imbricata*), and the Kemp's ridley turtle (*Lepidochelys kempii*) (USACE 2000).

Table 7 Summary of Sea Turtle Nesting for John U. Lloyd SRA, 1994-1999

Total Nests	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Loggerheads	190	248	206	181	253	210
Greens	14	10	18	5	21	2
Leatherbacks	1	0	0	2	3	0

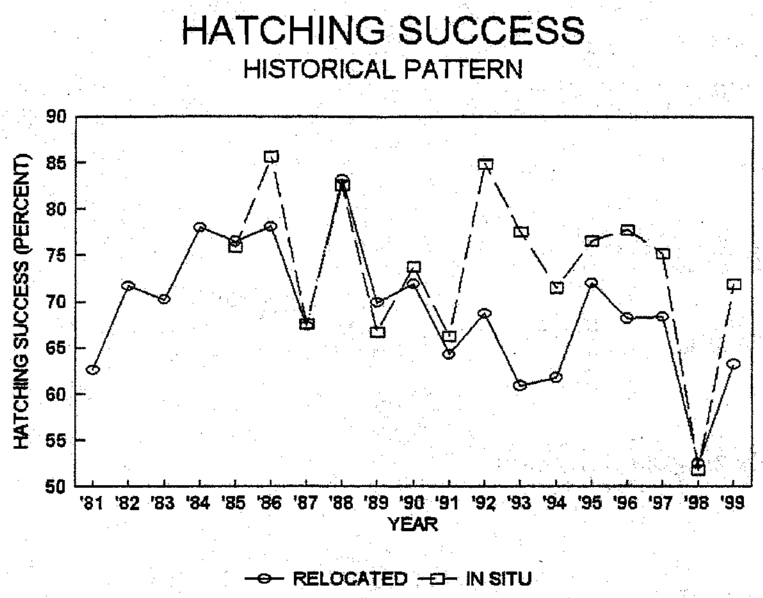
Source: Burney and Margolis, 1994-1999

Figure 13 Seasonal Pattern of Daily Loggerhead Nesting in Broward County, 1999



Source: Broward County Department of Natural Resource Protection, Technical Report 00-01. Sea Turtle Conservation Report 1999.

Figure 14 Historical Patterns of Yearly Hatchling Success for All Evaluated In-Situ and Relocated Sea Turtle Nests Since 1981



Source: Broward County Department of Natural Resources Protection Technical Report 00-01. Sea Turtle Conservation Report 1999.

4.0 IMPACT ASSESSMENT

This section describes the impacts of the proposed Study Elements and their Alternatives on terrestrial, wetland, and marine resources, as well as, threatened and endangered species. The analysis of direct impacts includes the immediate land area of the sites affected, and marine areas directly affected by, dredging, construction, and related activities (Table 8, and Figures 15, 16, 17, 18, 19, 20, 21). The analysis of indirect impacts includes the potential impacts related to these activities on the habitats directly adjacent to the areas proposed for expansion or upon marine mammals and fish within the water column (Table 8). An assessment of the direct, indirect, and cumulative impacts of the combined study elements cannot be determined until the recommended plan has been selected.

4.1 Alternatives S-1A, S1-B

Alternatives S-1A and S-1B entail the widening and deepening of the SAC including deepening of the OEC, IEC, MTB and removal of the widener shoal (Table 8). The alternatives differ in that S-1A includes the construction of a bulkhead along John U. Lloyd SRA, while S-1B includes the construction of a side-slope along John U. Lloyd SRA (Figures 15 and 16). The maximum depth being analyzed will be 58 feet in the OEC.

4.1.1 Impacts to Terrestrial Resources

Alternatives S-1A and S-1B would directly impact mangrove wetlands within the project boundaries. Approximately 2.34 acres of mangrove habitat along the western boundary of John U. Lloyd SRA extending from just south of the existing boat ramp northward to south of Nova University would be removed with the channel widening with alternative S-1A. Although a bulkhead would constitute the western portion of the channel, some impact to the mangrove habitat would still be required.

Alternative S-1B would differ from Alternative S-1A in that the eastern edge of the channel would be constructed with a side slope rather than bulkhead. Alternative S-1B would result in approximately 4.19 acres of impact to mangrove wetlands along the same corridor as Alternative S-1A, although the impact area would extend an additional 137 linear feet into John U. Lloyd SRA (Table 8) (Figures 15 and 16). Other SRA facilities that could be affected by this alternative include the existing boat ramp parking and an outdoor classroom facility west of the public beach parking area.

Table 8 Impact Acreages by Habitat Type

		Terrestrial Habitat Types		Marine Habitat Types								
	Footprint Area	Upland Acres	Wetland (Mangrove) Acres	Seagrass Out Channel	Seagrass In Channel	Scattered Rock/ Rubble In Channel	Scattered Rock/ Rubble Out of Channel	Low-Relief Reef In Channel	Low-Relief Reef Out of Channel	High Relief Reef In Channel	High Relief Reef Out of Channel	Unvegetated Bottom Acres
Study Element 1												
S-1A	283.51	0.28	2.34	0.62	1.47	16.10	0	11.47	2.15	3.13	0.73	245.22
S-1B	305.91	5.02	4.19	2.04	1.35	16.10	0	11.47	2.15	3.13	0.73	259.73
Study Element 5												
S-5A	36.63	9.35	2.01	0.66	0	0	0	0	0	0	0	24.61
S-5B	43.76	15.06	3.28	0.69	0	0	0	0	0	0	0	24.60
Study Element 6												
S-6A	42.24	0	18.82	0.69	0	0	0	0	0	0	0	22.73
S-6B	50.01	0	25.56	0.68	0	0	0	0	0	0	0	23.77
Study Element7												
S-7	13.37	0	0	0	0	0	0	0	0	0	0	13.37
Study Element 8												
S-8	19.74	0	0	0	0	0	0	0	0	0	0	19.74
Study Element 9												
S-9	32.32	1.83	8.48	0	0	0	0	0	0	0	0	22.01

Note: Acreages established by overlaying project plans over known natural resource polygons using ArcView.


LEGEND
Environmental Resource Survey Limits
S-1A Impacts
S-1A Footprint
High Relief Reef
Low Relief Reef
Scattered Rock and Rubble
Halophila johnsonii (Johnson Grass)
Mixed Halophila johnsonii, Halophila decipiens, and Halodule wrightii (Shoal Grass)
Halophila decipiens (Paddle Grass)
Fringing Mangrove Community
S-1A Project Footprint and Associated Impacts
Port Everglades Baseline
Environmental Resource Survey
Scale: 1" = 1,500'
Drawn By: MR
Date: May, 2001
Approved By:
DIAL, CORDY
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Figure 15
1500
0
1500
3000 Feet
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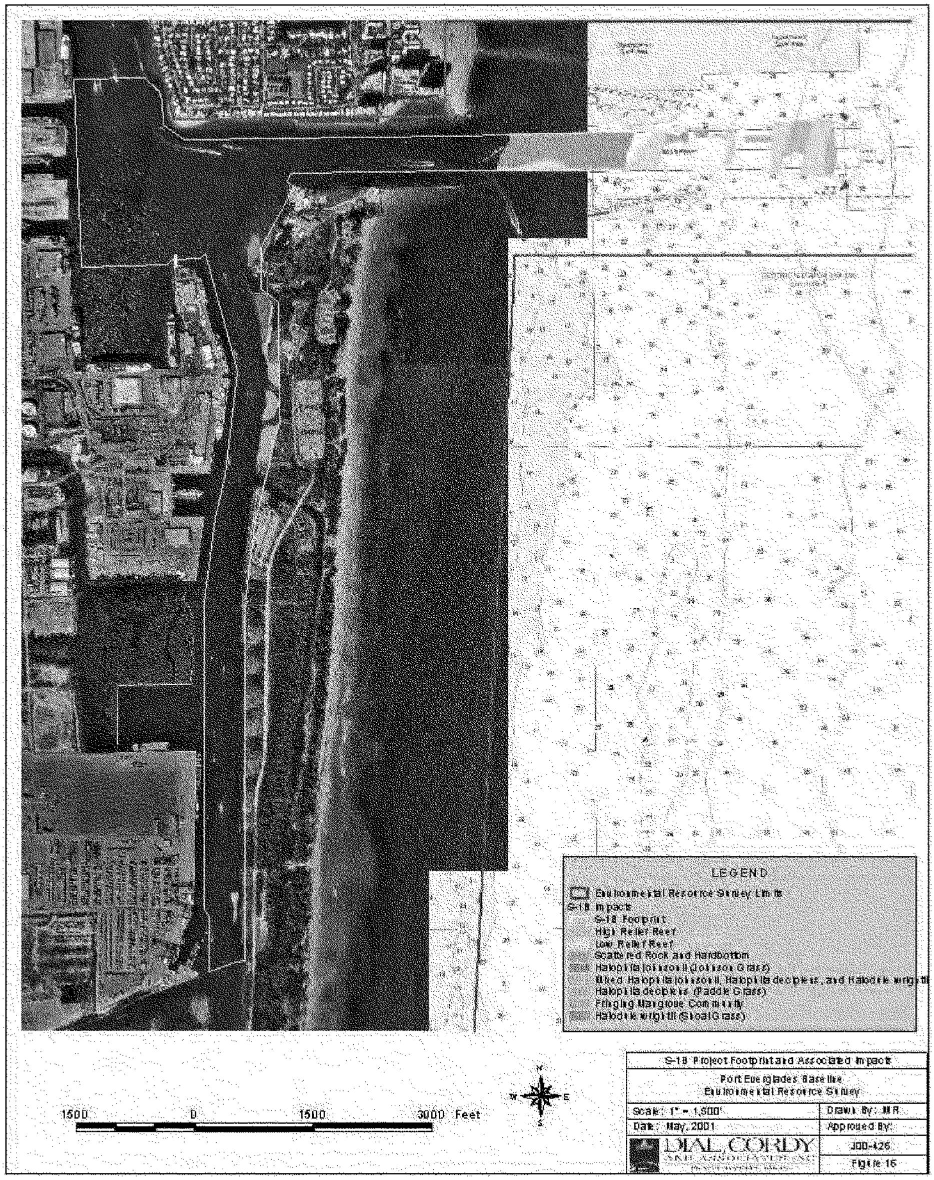
LEGEND
Environmental Resource Survey Limits
S-18 Impacts
S-18 Footprint
High Relief Reef
Low Relief Reef
Scattered Rock and Hardbottom
Halophila johnsonii (Johnson Grass)
Mixed Halophila johnsonii, Halophila decipiens, and Halodule wrightii
Halophila decipiens (Paddle Grass)
Fringing Mangrove Community
Halodule wrightii (Shoal Grass)
1500 0 1500 3000 Feet
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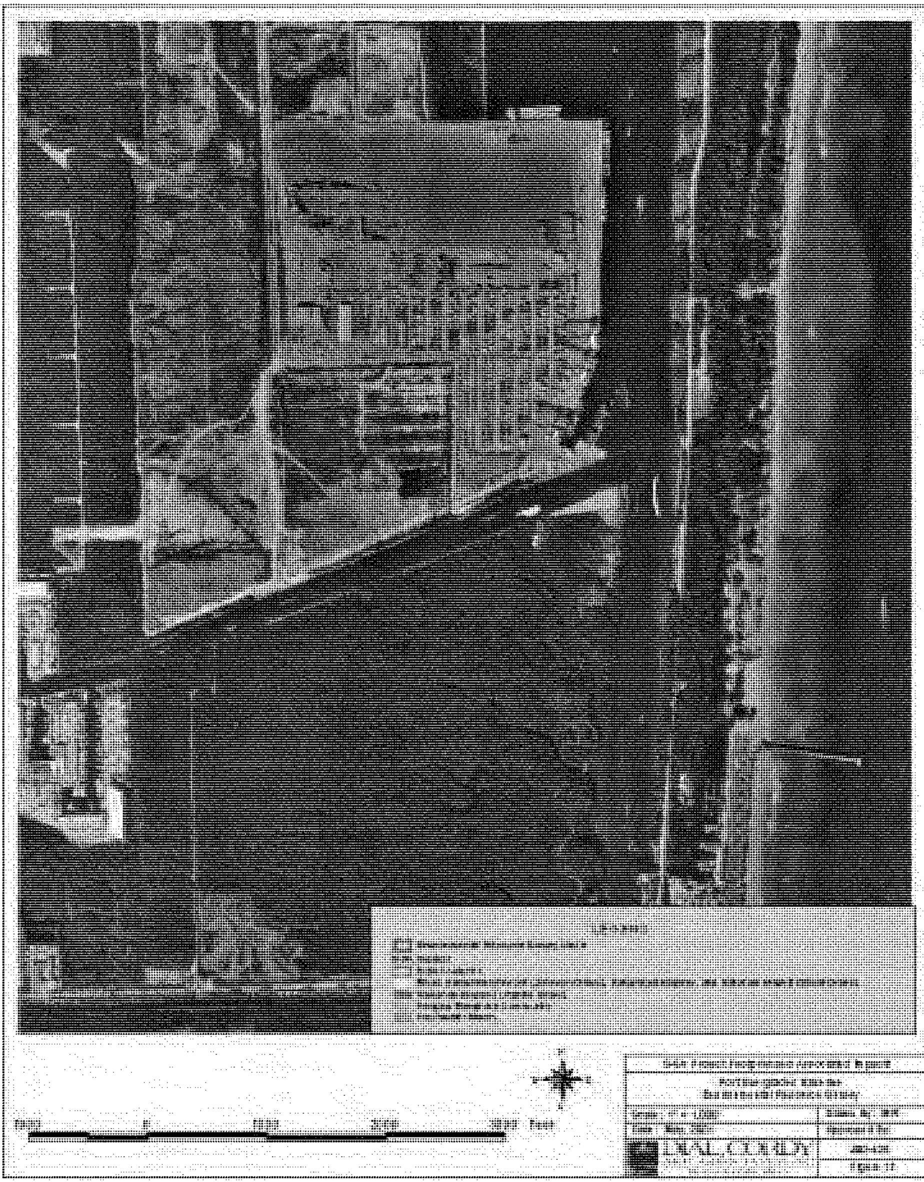
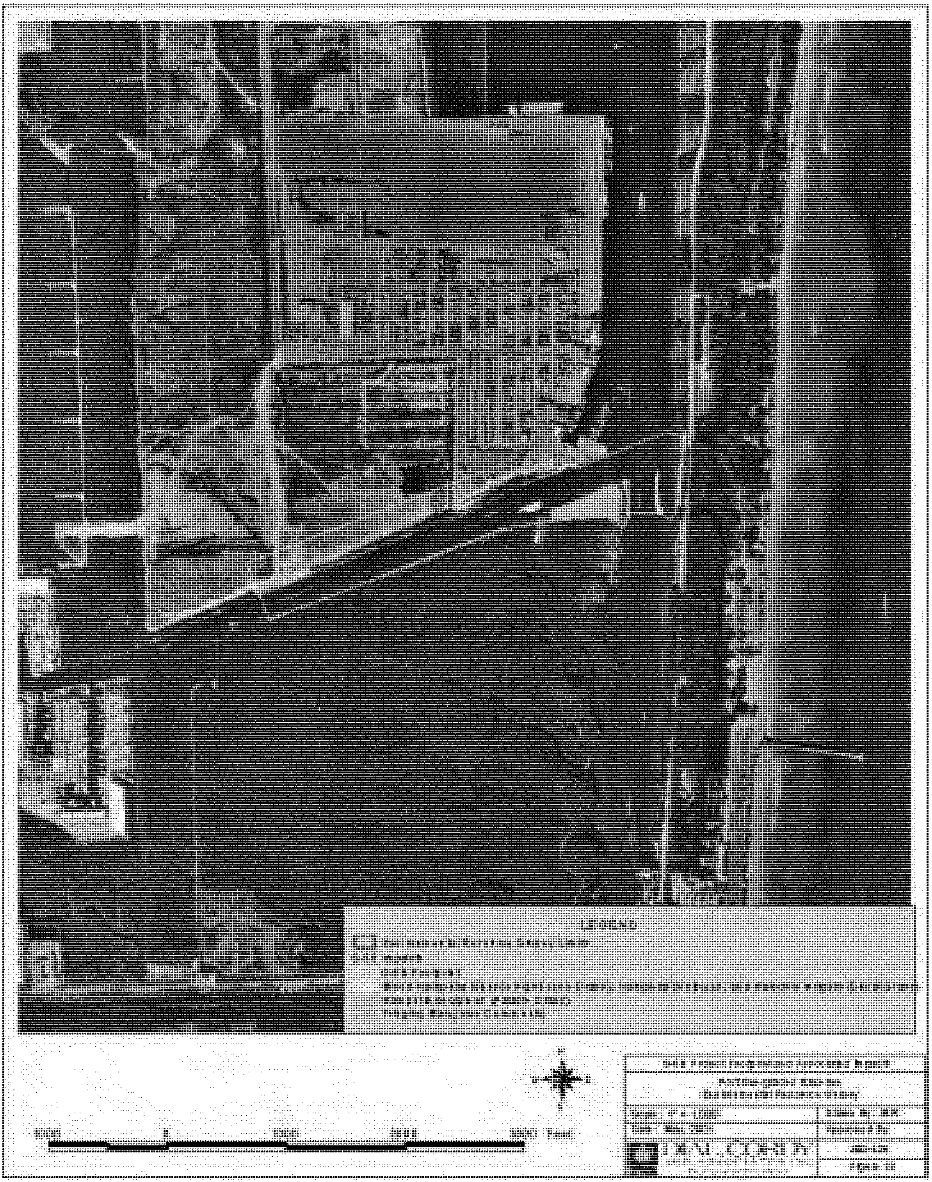
S-18 Project Footprint and Associated Impacts
Port Everglades Baseline
Environmental Resource Survey
Scale: 1" = 1,500'
Drawn By: MR
Date: May, 2001
Approved By:
DIAL, CORDY
J00-426
Figure 16

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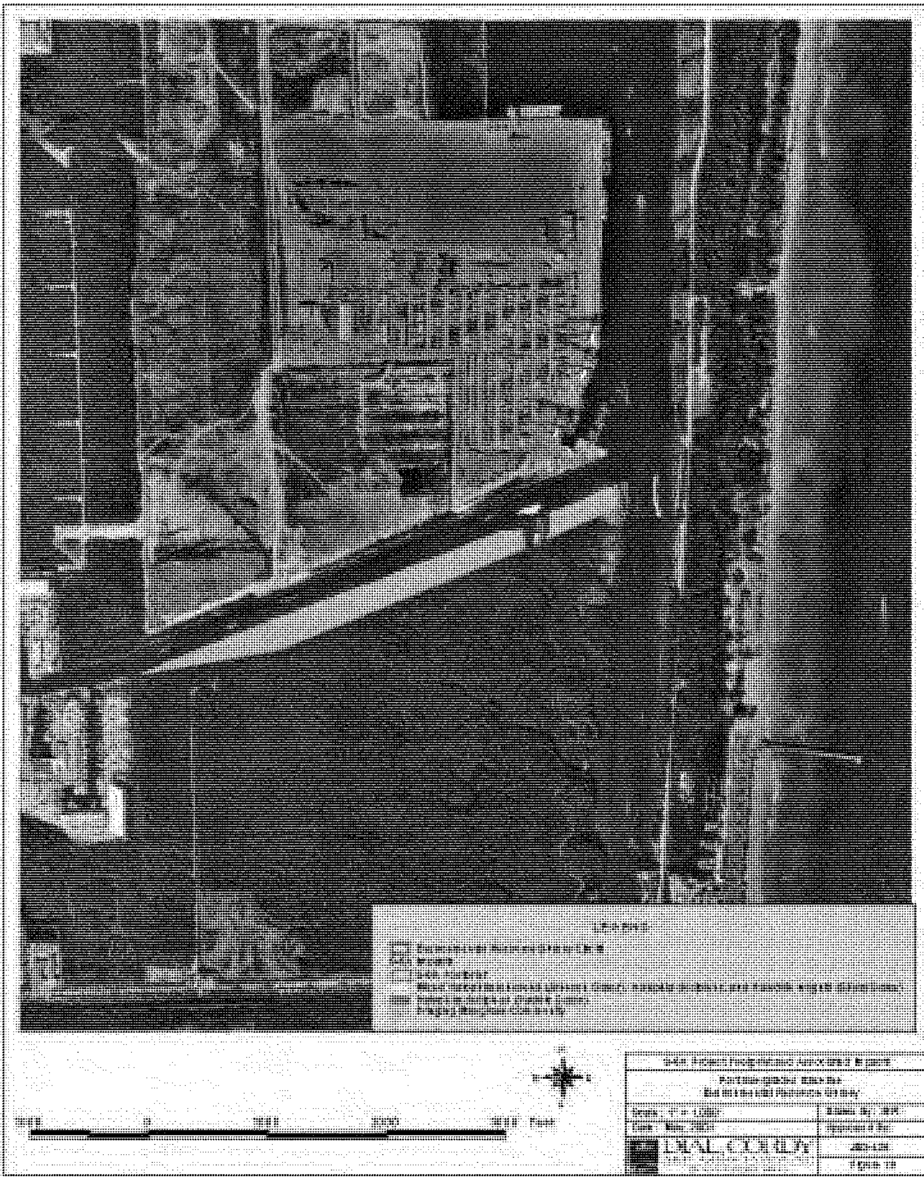

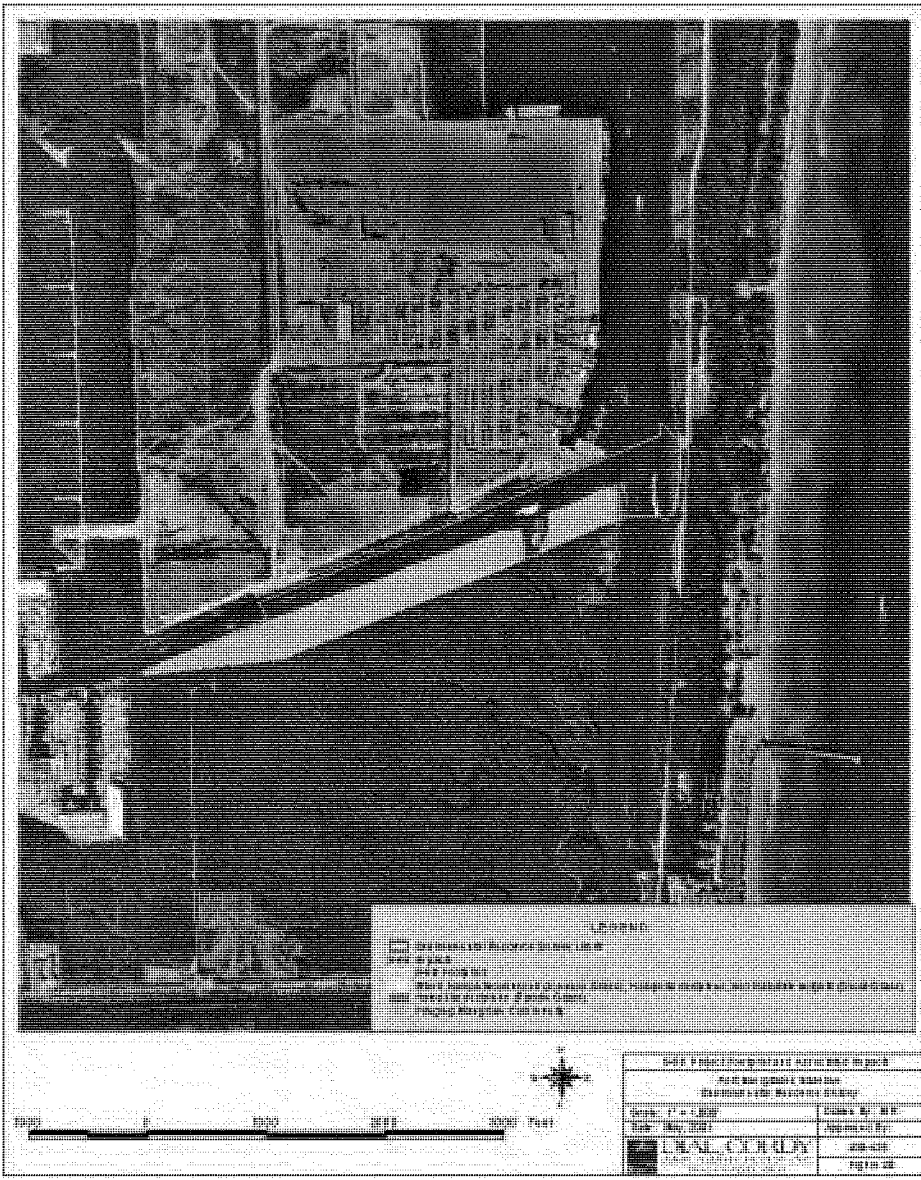
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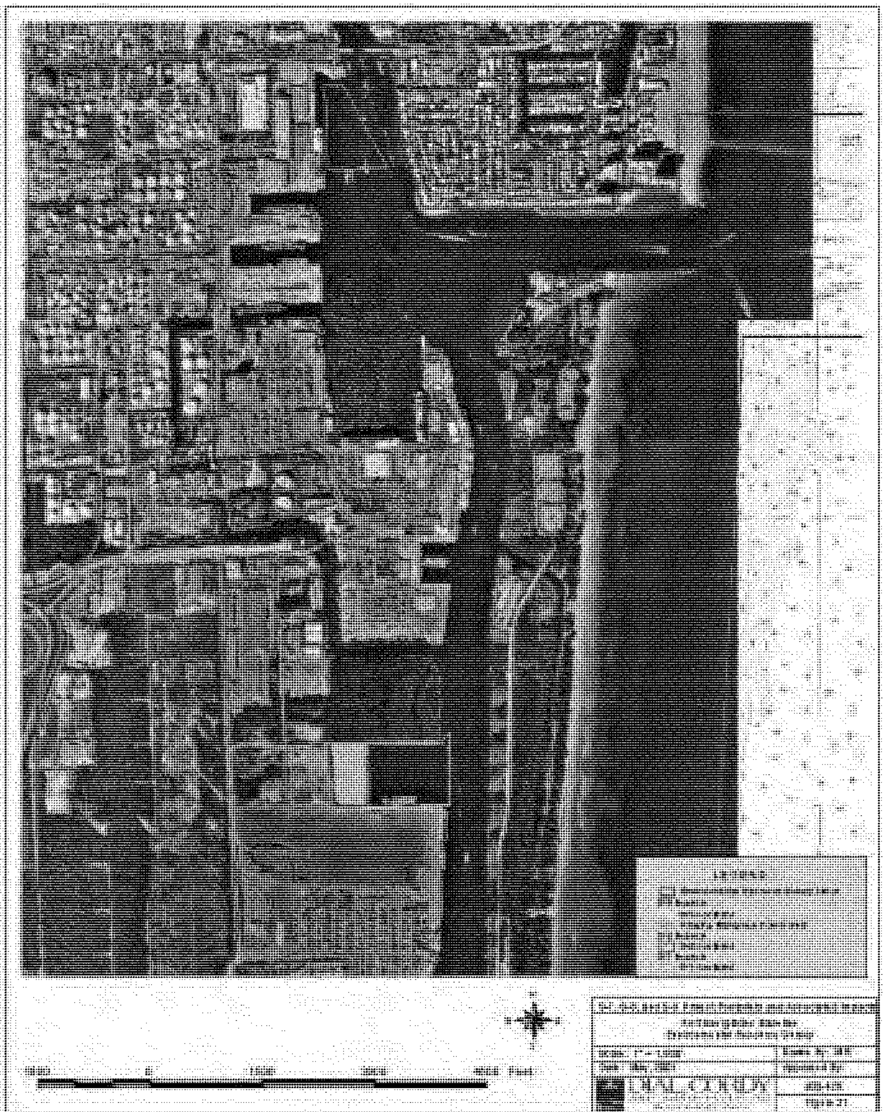
Feet



4.1.2 Impacts to Marine Resources

This section evaluates the potential direct and indirect impacts of the proposed modification of Alternatives S-1A and S-1B on the marine resources of the Port Everglades area as described in Section 3.3 and Table 8. The direct impacts to marine resources are based upon the area of habitat affected by the proposed modification (i.e. acres dredged, filled). Indirect impacts are those impacts that may potentially affect nearby habitats or communities and may be long-term or temporary in duration.

4.1.2.1 Impacts to Seagrass

There will be direct and indirect impacts to seagrass habitats along the eastern edge of the AICWW and widener shoal, and within the Outer Entrance Channel for both Alternatives S-1A and S-1B (Figure 15 and 16). These impacts will be both long-term and temporary and will impact the endangered marine seagrass species *H. johnsonii*.

4.1.2.1.1 Direct Impacts

Direct impacts to seagrass as a result of either Alternative S-1A or S-1B include the removal of seagrass habitat along the AIWW and the widener shoal during dredging activities. Alternative S-1A will impact 0.62 acres of seagrass habitat outside of the channel and 1.47 acres within the channel, while the creation of the side-slope with Alternative S-1B will result in 2.04 acres of impact outside the channel and 1.35 acres within the channel. Alteration of seagrass habitat will result from the dredging associated with deepening and widening, and also from the creation of either a bulkhead with Alternative S-1A, or a the sideslope with Alternative S-1B. The species affected include *H. johnsonii*, *H. decipiens*, and *H. wrightii*. These seagrass beds are very patchy and have cover abundance values of less than 5% (Table 4). The densities of these seagrasses are also very sparse, with average values being 0.32, 0.31, and 0.14, respectively (Table 4).

Dredging will result in the loss of seagrass habitat due to removal, however, increases in depth or changes in bottom type that will result from the dredging may alter future growth patterns of seagrass in the area. The loss of these communities will result in the direct loss of habitat for marine animals. In particular, seagrass habitat is important in the juvenile life histories of many fishes and invertebrates. These juvenile species in turn, are a primary source of prey species for larger predatory fishes and invertebrates. There would be a net loss of primary and secondary production resulting from the loss of seagrass habitat.

4.1.2.1.2 Indirect Impacts

Indirect impacts to seagrass habitat from implementing Alternative S-1A or Alternative S-1B would include both temporary and long-term changes of habitats in the area associated with dredging. The areas just north of the widener cut and IEC and the seagrass habitats south of the DCC are subject to indirect impacts (Figures 8 and 9). Should dredging activities result in re-suspension of high concentrations of fine sediments into the water column, tides and currents may transport these sediments over adjacent seagrass beds where they may be deposited. Potential indirect losses of habitat or a temporary reduction in seagrass productivity and habitat quality may result. Other indirect impacts may include the temporary displacement of fish from these habitats adjacent to the dredging activities. This would result in short-term changes in the community structure within this area.

4.1.2.2 Impacts to Hardbottom and Reef

Widening and deepening associated with either Alternatives S-1A or S-1B would result in both direct and indirect impacts to hardbottom and reef communities within the Port Everglades OEC and IEC and adjacent habitats (Figure 11). These impacts would be both permanent and temporary.

4.1.2.2.1 Direct Impacts

Direct impacts to hardbottom and reef communities will occur as a result of the dredging process to widen and deepen the federal channel. As shown in Table 8 and Figures 15 and 16, there will be 14.60 acres of impact to reef habitat within the channel including 11.47 acres of low- relief reef and 3.13 acres of high-relief reef. New impacts outside the existing channel will include 2.15 acresof low-relief reef and 0.73 acre of high-relief reef. Approximately 27.57 acres of previously dredged hardbottom habitat (scattered rock/rubble 16.1 acres, low-relief reef 11.47) located in the OEC will be impacted by dredging. The impacts to these areas while direct would be temporary in nature, as marine life would re-colonize these areas following dredging. The area impacted consists primarily of a sponge-algal community consisting of the sponges *Ircinia* sp., *Niphates* sp., *Cliona* sp., and *Iotrochota* sp., and dominant algae associated with these communities are in the genus *Caulerpa* sp., *Jania* sp., *Laurencia* sp., *Dictyota* sp. and *Halimeda* sp. (Dodge 1991, Vare 1991). Interspersed among these sponges are colonial anemones (*Zoanthus* sp.), and hydrocorals (*Millepora alcicornis*).

Direct habitat loss to reef assemblages associated with dredging would be permanent. Loss of coral reef due to dredging would result in a change of the community structure offshore.

Impact to the reef habitat at the end of the OEC would result in direct removal of many coral species including a high density of gorgonians. These gorgonian corals are primarily of *Eunicea* sp., *Plexaura* sp. and *Pseudopterogorgia* sp. Hard coral species also make up a significant part of the reef assemblages in this area including *Porites asteroides, Diploria clivosa, Siderastrea siderea,* and *Montastrea cavernosa* (Britt 1977; Dodge 1991; Vare 1991). These coral species provide an important habitat for many other fish and invertebrate species.

4.1.2.2.2 Indirect Impacts

Indirect impacts to hardbottom and reef habitat associated with Alternatives S-1A or S-1B may include temporary changes to the habitats adjacent to the area being dredged. In particular, the reef and hardbottom habitats just outside of the entrance channel or within the local area offshore of the Port may be affected (Figures 15 and 16). Indirect impacts associated with the dredging activities of Alternatives S-1A or S-1B, may include the re-suspension and deposition of sediments within the adjacent area, the temporary displacement of fish and invertebrates from the area, and also acoustic effects of the associated dredging and blasting on marine life.

Dredging activities within the OEC may re-suspend fine sediments into the water column. This re-suspension of sediments may result in temporary periods of high turbidity within the area. The temporary effects of this high turbidity may include a loss of photosynthetic activity over the reef. Also, suspended sediments will be transported with the wind and tides and may be deposited on nearby coral reef communities. While corals can adjust and clean themselves with light deposition of sediments, if this deposition is too severe or long in duration it could result in the loss of the hard coral species. Monitoring of coral heads and collection of suspended sediments during past channel dredging of Port Everglades showed that little or no impact occurred (CSA 1981).

Other indirect effects include the displacement of fishes and invertebrates during the dredging activities. This would result from the loss of habitat in the area dredged and disturbance created by the dredging activities. The majority of these impacts would be short-term in nature and adjacent community assemblages would return to near normal levels after dredging activity ceased.

4.1.2.3 Impacts to Unvegetated Habitats

4.1.2.3.1 Direct Impacts

A large part of the area to be dredged includes areas of un-vegetated habitats. This habitat includes the softbottom habitats in the area as described by Messing and Dodge (1997) as well as others, and also the area of the SAC Channel (Figure 10) which is composed of softbottom habitat as well as scattered rubble from previous dredging activities. Both Alternative S-1A and

S-1B would include temporary impacts to benthic organisms utilizing these un-vegetated habitats within the Federal Channel and Port. Direct impacts to these softbottom communities would result from the removal of dredged material. In total there would be 214 acres of un-vegetated habitat altered during dredging during S-1A and 217.5 acres impacted with Alternative S-1B. As long as the areas remained as viable aquatic habitat following dredging, benthic populations in these areas would re-establish, and these losses would be temporary and short-term in nature.

4.1.2.4 Impacts to EFH

Alternatives S-1A and S-1B would impact designated EFH including estuarine emergent vegetation, mangrove shrub/scrub, live/hard bottom, coral reef, seagrass, and water column (Table 6). Managed species include the Snapper/Grouper complex, pink shrimp and spiny lobster. Both temporary and permanent impacts would occur.

Temporary impacts as a result of dredging the Entrance Channel would occur within the water column and to the softbottom and hardbottom benthic communities. Dredging and construction activities will temporarily impact benthic organisms that serve as food sources for EFH species. This foraging habitat would be temporarily unavailable. Since construction of other project elements will be phased over time and there is a large adjacent area left for foraging, these impacts should be minimal. Dredged habitats in the channel will be re-colonized by a similar benthic community within one year of dredging (Taylor et. al 1973).

Important aspects of EFH that may be affected by both Alternatives S-1A and S-1B include the loss of spawning, nursery, foraging and migration habitats. Particularly this would impact species of the Snapper/Grouper Complex, the spiny lobster and the pink shrimp. The most important losses to EFH within the area proposed for dredging include the loss of seagrass and coral reef. The coral reef habitats are listed as EFH-HAPC by the SAFMC. Loss of these two habitats will result in a loss of habitat critical in the spawning and early life stages for Snapper-Grouper Complex, which is consists of 73 species that commonly use the inshore habitats for part of their life cycle. These include blue stripe grunts, French grunts), mahogany snapper, yellowtail snapper, and Red grouper. Seagrass areas impacted include approximately 2.09 acres of seagrass composed of *H. johnsonii*, *H. decipiens*, and *H. wrightii* with S-1A and 3.39 acres with S-2B. Reef impacts include the removal of 17.48 acres of reef habitat. Hardbottom habitats will re-colonize with benthic invertebrate species after dredging, however the loss of coral reef habitat will be permanent.

Blasting may be proposed as one of the methods for removal of rock during dredging. Blasting will have a direct impact on fish species within the Port area. Previous studies (USACE 1996; O' Keefe 1984; Keevin and Hempen 1997; Young 1991) have addressed the impacts of blasting on fishes. Fishes with air bladders are particularly more susceptible to the effects of blasting, while aquatic organisms without air bladders (e.g. shrimp, crabs, etc) are highly resistant to the impacts of blasting (Keevin and Hempen 1997). Small fish are the most likely to be impacted the greatest by blasting. Studies by the Corps of Engineers indicate that blasts in rock do not have as great an impact as those detonated in open water (USACE 1999). In other projects requiring underwater explosives, buffer zones of 140 feet have proven to be effective in reducing the impacts to fish (Keevin and Hempen 1997).

Implementation of S-1A or S-1B would result in the permanent loss of 2.34 and 4.19 acres of estuarine mangrove, respectively; along John U. Lloyd SRA. This loss of mangrove habitat would result in a loss of EFH habitat for juvenile fishes. These mangrove areas serve a nursery for many managed species including pink shrimp, the spiny lobster, and members of the Snapper-Grouper Complex. Mangrove habitat is also important for many species of crabs, shrimp, and fishes not managed but serve as prey species for managed species. These include the blue crab, needlefishes (Belonidae), silversides (Athernidae), killifishes (Cyprinodontidae) and livebearers (Poecillidae) (Odum 1982).

4.2 Alternatives S-5A, S-5B

Alternative S-5A and S-5B involve widening and deepening of the DCC to the north with a turning basin at the SAC. Alternative S-5A includes the construction of a bulkhead along the north side of the DCC and the creation of a bulkhead along the southern side of the DCC just north of West Lake Park (Figures 17 and 18). Alternative S-5B differs from S-5A in that the bulkhead along the southern side of the DCC would be replaced with a sideslope just north of West Lake Park (Figures 17 and 18). The impacts of these two alternatives are outlined in Table 8.

4.2.1 Impacts to Terrestrial Resources

Alternative S-5A would impact approximately 2.01 acres of mangrove wetlands along a 6 to 10 foot wide strip at the southern boundary of the DCC due to bulkhead construction, and for the turning basin construction at the juncture of the DCC and the AIWW. Alternative S-5B would impact approximately 3.28 acres of mangrove wetlands for the turning basin construction at the juncture of the DCC and the AIWW and associated sideslope. (Figures 17 and 18).

4.2.2 Impacts to Marine Resources

This section describes the potential direct and indirect impacts of construction activities as a result of Alternative S-5A or Alternative S-5B. The total impact acreages of these actions are summarized in Table 8. The direct impacts would involve the direct removal of habitat along the DCC, and SAC, while indirect effects are those effects that will affect nearby habitats and communities. All of these effects may be long-term or temporary in duration.

4.2.2.1 Impacts to Seagrass

Alternatives S-5A and S-5B have both direct and possibly indirect effects on seagrass along the southern edge of the DCC and also the SAC (Figures 17 and 18). These impacts will be both long-term and temporary and will impact *H. johnsonii.*

4.2.2.1.1 Direct Impacts

Dredging efforts to deepen and widen the DCC for implementation of Alternatives S-5A and S-5B will include the removal of approximately 0.66 and 0.69 acres of seagrass habitat, respectively. This habitat is a mixed bed of *H. decipiens, H. wrightii*, and *H. johnsonii*. This seagrass habitat occurs along the southern side of the DCC canal, near the SAC where a tidal creek merges with the DCC (Figures 17 and 18). This is the only seagrass encountered during the resource survey of the DCC. The seagrass here is very patchy and the bed overall is very poor, with average abundance values of 0.1000 and a density of 0.0031 (Table 4). *H. johnsonii* was so sparse that during sampling it was observed within the bed however, it was so scattered that it did not fall within any of the quadrats sampled along the study transect. The loss of this seagrass along the DCC will result in the loss of important seagrass habitat in this area, however; this habitat, overall, is not very high quality.

4.2.2.1.2 Indirect Impacts

Indirect impacts associated with Alternatives S-5A and S-5B would include both temporary and possible long-term impacts to the adjacent habitats. Dredging the DCC to accommodate larger vessels may re-suspend fine sediments into the water column. These sediments may increase turbidity and cut down on the photosynthetic activity of the adjacent seagrass areas within the SAC (Figures 17 and 18). Re-suspended sediments could also be transported and redeposited onto adjacent seagrass beds, resulting in long-term loss of habitat. Other indirect impacts include the displacement of fishes and invertebrates during dredging activities that would result in short-term changes in community structure.

4.2.2.2 Impacts to Unvegetated Habitats

4.2.2.2.1 Direct Impacts

The area impacted by Alternatives S-5A or S-5B includes approximately 24.6 acres of unvegetated habitat along the DCC and SAC (Table 8). This habitat consists primarily of areas that had been dredged in the past. This habitat is a mixture of unvegetated sediments and rubble left from prior dredging events. The most consistent fauna within these communities consists of several taxa of polychaete, oligochaetes, mollusks, sipunculans, peracarid crustaceans, platyhelminthes, and nemertina (Messing and Dodge 1997, Rudolph 1986).

Direct impacts to these habitats will occur, but the impacts will be short-term in duration as community structure can be expected to re-establish itself following dredging.

4.2.2.3 Impacts to EFH

Impacts to EFH with the implementation of Alternatives S-5A or S-5B include impacts to mangrove scrub/shrub habitat, seagrass, and water column (Table 6). These impacts may impact managed species such as pink shrimp, spiny lobster, and members of the Snapper-Grouper Complex, as well as there prey species. These impacts would be both temporary and permanent.

Temporary impacts will occur along the DCC and SAC as a result of the dredging activities. The dredging will temporarily impact approximately 24.6 acres of unvegetated habitat and approximately 30 acres of water column. The dredging and construction of bulkheads will temporarily impact organisms using the DCC for migration and will also impact benthic prey species utilized by managed species within the area. The area of the DCC and SAC to be dredged will re-colonize following the completion of dredging activities and similar benthic communities can be expected to re-colonize the area.

The seagrass habitat impacted (0.66 or 0.69) along the DCC is an EFH-HAPC as listed by the SAFMC. Loss of this habitat may directly impact spawning, nursery, and foraging habitat for managed species within the Port. In particular, members of the Snapper-Grouper Complex, spiny lobster, and pink shrimp, may lose essential habitat important to their early life histories. Seagrass occurring in this area may serve as a nursery for the early development of these managed species, in addition to other species in the area of the Port.

4.3 Alternatives S-6A, S-6B

Alternatives S-6A and S-6B are another option for the deepening and widening of the DCC and SAC. S-6A would include the deepening and widening of the DCC with a turning basin at the SAC, construction of a bulkhead along the north side of DCC, and the creation of a bulkhead along the south side of the DCC into West Lake Park (Figures 19 and 20). Alternative S-6B includes the deepening and widening of the DCC and SAC, with construction of a bulkhead along the northern side of the DCC and a sideslope constructed into West Lake Park on the southern side (Figures 19 and 20).

4.3.2 Impacts to Terrestrial Resources

Alternative S-6A would impact approximately 18.82 acres of mangrove wetlands along a 160 to 230 foot wide strip at the southern boundary of the DCC and for the turning basin construction at the juncture of the DCC and the AIWW (Table 8) (Figure 19).

Alternative S-6B would impact approximately 25.56 acres of mangrove wetlands along a 250- to 320-foot wide strip at the southern boundary of the DCC and for the turning basin construction at the juncture of the DCC and the AIWW. Alternative S-6B differs from Alternative S-6A in that side slopes would be utilized to maintain channel integrity as opposed to bulkhead construction (Figure 19).

4.3.3 Impacts to Marine Resources

Impacts to marine resources in relation to Alternatives S-6A and S-6B will be evaluated in this section. Direct impacts are based on the number of acres of affected habitat, while indirect impacts are those impacts that may potentially affect nearby and adjacent habitats. These impacts may be long or short-term in duration.

4.3.3.1 Impacts to Seagrass

Implementation of either Alternatives S-6A or S-6B will result in both direct and indirect impacts to marine seagrass habitat (Figure 20). These impacts will be both temporary and permanent, and will directly affect the endangered *H. johnsonii*.

4.3.3.1.1 Direct Impacts and Indirect Impacts

Alternatives S-6A and S-6B would result in the removal of approximately 0.69 and 0.68 acres of marine seagrass habitat, respectively (Figures 19 and 20). These impacts are similar to those described in Section 4.2.2.1.

4.3.3.2 Impacts to Unvegetated Habitats

Impacts to unvegetated habitats with Alternatives S-6A or S-6B would include direct removal of either 22.73 or 23.77 acres of unvegetated marine habitat, respectively (Figures 19 and 20) (Table 8). These impacts would be similar to those described in Section 4.2.2.2, and this habitat should re-colonize following the completion of the dredging activities.

4.3.3.2.1 Direct Impacts

4.3.3.3 Impacts to EFH

Habitats that are designated as EFH that would be affected through either Alternative S-6A or Alternative S-6B include mangrove shrub/scrub, seagrass, unvegetated bottom, and water column (Table 6). These impacts would be both permanent and temporary and affect SAFMC managed species such as the spiny lobster, pink shrimp, and members of the Snapper-Grouper Complex, and related prey species.

Impacts to the unvegetated, water column, and seagrass habitats would be identical to the impacts described in Section 4.2.2.3 in relation to Alternatives S-5A or S-5B. However, the impacts to the mangrove habitats along West Lake Park are much greater with Alternatives S-6A and S-6B. Alternatives S-6A and S-6B impact 0.69 and 0.68 acres of seagrass, respectively. This mangrove habitat is high quality EFH and is listed as EFH-HAPC by the SAFMC. Mangrove habitat serves as nursery habitat for many of the managed and related species under the SAFMC plan (SAFMC 1998). This habitat is important in the life histories of managed species such as grunts, snappers, spiny lobsters, and their prey species (e.g., crabs, baitfish, and shrimp) (Odum et. al 1982). Removal of 18.82 or 25.56 acres of mangrove habitat along the DCC may have significant effects on the community structure and food chain within the study area through the loss of this habitat and its associated production.

4.4 Alternatives S-7, S-8

Alternative S-7 is the deepening of the NTB at Berths 2 and 3, while Alternative S-8 is the deepening of the STB to accommodate vessels at Berths 16, 17, and 18 (Figure 21). This deepening is to allow vessels with a larger draft to utilize the Port facilities.

4.4.1 Impacts to Marine Resources

Impacts to marine resources in relation to Alternatives S-7 and S-8 would include impacts to unvegetated bottom habitat and water column. These impacts would be both direct and indirect, and long and short-term in duration.

4.4.1.1 Impacts to Seagrass

4.4.1.1.1 Direct Impacts

There will no direct impacts to seagrass associated with Alternatives S-7 or S-8.

4.4.1.1.2 Indirect Impacts

Deepening of the NTN may have some indirect effects on the seagrass habitats within the Port. Dredging associated with deepening may re-suspend fine sediments into the water column. These sediments may increase turbidity and decrease photosynthetic activity. The NTN and IEC experience strong currents during tidal changes. These currents will redistribute these sediments to other areas within the Port and offshore and may deposit them on nearby seagrass habitats. This deposition of sediments may have adverse effects on these environments, including the loss of photosynthetic activity. Seagrass habitats adjacent to the area directly impacted by dredging may also experience temporary displacement of fish and invertebrate communities. The dredging activities will disrupt these communities near the northeastern corner of the TN and IEC. These communities should re-establish themselves once dredging is completed and any impacts would be short-term.

4.4.1.2 Impacts to Unvegetated Habitats

4.4.1.2.1 Direct Impacts

The largest area of impact with Alternative S-7 and S-8 are the unvegetated bottom habitats within the NTB and STB. This area consists of bottom habitats that have been dredged in the past, and are composed of unvegetated sediments and rubble. Alternative S-7 will impact 13.37 acres of unvegetated bottom, while Alternative S-8 will impact 19.74 acres (Table 8). As with the other unvegetated habitats discussed for the other alternatives, the impacts would be temporary and short-term. and the bottom within the NTB and STB would be expected to re-colonize shortly after dredging ceased.

4.4.1.3 Impacts to EFH

The proposed deepening of the NTB and STB associated with Alternatives S-7 and S-8 would impact designated EFH including unvegetated bottom and water column.(Tables 6 and 8) (Figure 21). These alternatives would potentially impact the migration, foraging, and reproductive activities of managed species within the area.

Temporary impacts to the water column and benthic communities would occur. Dredging activities would temporary disrupt normal migration patterns within the area of the IEC, NTB, and STB. The dredging would also impact benthic communities in this area, which may provide habitat for prey species. This loss of foraging habitat would be temporary, and communities should recover within one year following dredging.

Most importantly this area may provide an important corridor for juvenile/adult fishes and invertebrates, migrating from inshore mangrove and seagrass communities to the reef habitats offshore. Dredging may temporarily impact these migration patterns in and out of the Port through the channel. These impacts may result in displacement of species during dredging and also hinder migration through the channel and AICWW. With the completion of dredging activities, these patterns should return to normal.

4.5 Alternatives S-9

Alternative S-9 involves extending the TN to the west and northeast to provide additional berthing and turning area (Figure 21). Impacts associated with Alternative S-9 include direct and indirect impacts to mangrove, unvegetated bottom, and the water column. These impacts will be both long and short-term in duration.

4.5.1 Impacts to Terrestrial Resources

Alternative S-9 would directly impact approximately 8.48 acres of mangrove wetlands (Table 8) (Figure 21). The mangrove wetlands that would be impacted by this alternative consist of a terminal rectangular area located west of the existing TN and are included in a designated wetland conservation area. The remaining 37 acres of mangrove wetlands in the conservation area would not be affected.

4.5.2 Impacts to Marine Resources

Alternative S-9 will directly and indirectly impact marine resources within the Port Everglades area. Marine resources impacted include unvegetated bottom and water column.

4.5.2.1 Impacts to Unvegetated Habitats

4.5.2.1.1 Direct Impacts

Alternative S-9 will directly impact 22.01 acres of unvegetated bottom. This area is primarily unvegetated sediments and rubble left from prior dredging events. This habitat is of very low quality and plays a minimal role in terms of primary and secondary estuarine productivity within the Port. Any impacts to this softbottom community will be short-term in duration. It is expected that the soft bottom biotic community will recover from the disturbance within one-year following dredging.

4.5.2.2 Impacts to EFH

Expansion of the TN with Alternative S-9 would impact EFH. In particular, it would impact mangrove shrub/scrub habitat, unvegetated bottom, and the water column. Impacts would be both direct and indirect and may impact managed species. The loss of 8.48 acres of mangrove habitat with expansion to the west would be the most significant impact (Figure 21) (Table 8). As described in earlier sections, this mangrove habitat is primary nursery habitat for marine fishes and invertebrates and removal would have significant effects on the community structure and food chain support within the area of the Port through the loss of this habitat and its related functional values. .

4.6 Impacts to Threatened and Endangered Species

This section assesses the potential impact to federally listed species that would result from the construction and/or operation of the Proposed Study Elements. Direct impacts to these species would include injury, mortality, or disturbance of individuals that directly affect the life history of these animals. Direct impacts would include those that may arise as a result of dredging, filling, and loss or modification of habitats. Indirect impacts would include impacts occurring to nearby habitats or animals within nearby areas either during or after completion of dredging and construction activities.

4.6.1 Impacts to Threatened and Endangered Species - All Alternatives

Federally listed species that may be potentially affected within the study area are shown in Table 9. These include the manatee, five species of sea turtle, and the seagrass *H. johnsonii*. Dredging activities associated with construction would present potential for direct mortality or injury to both manatees and sea turtles that may be moving through the area. The potential is greatest for Alternatives S-1A or S-1B, S-7, S8, and S-9. These potential impacts could be lessened with the

Table 9 Impact Analysis of Study Elements

	Seagrass		Hardbottom		Coral Reef		Mangrove		Sea Turtles		Manatees		H. johnsonii	
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
Study Element 1														
S-1A	3	1	1	2	3	2	1	1	1	1	2	1	3	1
S-1B	3	1	1	2	3	2	2	1	1	1	2	1	3	1
Study Element 5														
S-5A	2	0-1	0	0	0	0	2	1	0	0	1	1	3	0-1
S-5B	2	0-1	0	0	0	0	1	1	0	0	1	1	3	0-1
Study Element 6														
S-6A	2	0-1	0	0	0	0	3	1	0	0	1	1	3	0-1
S-6B	2	0-1	0	0	0	0	3	1	0	0	1	1	3	0-1
Study Element 7	0	0-1	0	0	0	0	0	0	0	0	2	1	0	0-1
Study Element 8	0	0-1	0	0	0	0	0	0	0	0	2	1	0	0-1
Study Element 9	0	0-1	0	0	0	0	2	1	0	0	2	1	0	0-1
No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0

0 – No impact
1 – Minor Impact
2 – Moderate Impact
3 – Significant Impact

use of seasonal restrictions on the amount of dredging allowed in peak seasons (i.e. manatees in winter, turtles' summer nesting season), and by using experienced observers during periods of dredging activity.

The highest potential impact to threatened and endangered species may be the use of explosives to remove areas of rock within the OEC, IEC, and SAC. Both the pressure and noise associated with blasting can physically damage marine mammals and turtles. Noise and pressure effects to manatees have not been well documented; therefore, this discussion will assume that manatees will be impacted similar to dolphins. The threshold of sea turtles to impacts is probably similar to dolphins (Department of the Navy 1998). Previous studies have determined that a blasting zone of 3,500 feet would be sufficient to minimize impacts to turtles and marine mammals (USACE 2000). This blasting zone should be monitored by experienced observers to assure no animals are within this zone prior to blasting. Adjustments can be made to the size of this blasting zone, depending on the type and size of the charges used and the actual noise and pressure measurements recorded during blasting. Further analysis will be required once a blasting plan has been prepared.

Other direct impacts may include the loss of habitat or minor impacts on secondary production. If all Study Elements are constructed a maximum of 4.6 acres of seagrass habitat could be lost. This habitat is potential foraging habitat for manatees that travel through this area. During winter months a large population of manatees use the warm water refuge at the FP&L Power Plant at Port Everglades. Given the large numbers of manatees in the area and the limited amount of seagrass present, any loss of seagrass may represent a loss of foraging habitat for manatees.

Dredging and construction activities in the area may also alter migration routes of manatees through the area. Care should be taken in winter months to assure that migration routes of manatees utilizing the FP&L warm refuge remain open and that dredging activities do not disturb the animals using this area. Any disturbance of manatees would be considered harassment of a marine mammal under the Marine Mammal Protection Act of 1972.

Removal of hardbottom and coral reef habitats for deepening of the Entrance Channel may eliminate some potential foraging habitat of marine turtles. However, due to the large area of similar habitat in the area, and the fact that these habitat areas will re-colonize over time, the impacts to turtle foraging habitat will most likely be temporary.

Direct impacts to sea turtles may occur if dredge material is used as renourishment material for the beach along John U. Lloyd SRA. As many as 212 sea turtle nests are found annually along this stretch of beach and any modifications to the beach could have an impact on nesting activity. Placement of dredge material during non-nesting periods and assuring the proper material grain size during placement will make any impacts associated with this insignificant. Dredging operations would require turtle observers be placed on board the dredge during active dredging to insure no incidental take to juvenile sea turtles occur.

Dredging will result in the removal of up to 2.25 acres of seagrass habitat where *H. johnsonii* occurs along the AICWW and DCC. This impact will include the direct removal of *H. johnsonii.* Changes in bottom depth through deepening and widening efforts within the Port, may limit the amount of available habitat suitable for *H. johnsonii* re-colonization. Since *H. johnsonii* does occur outside of the area directly impacted, it is reasonable to assume it would re-colonize within the Port area after construction halted assuming viable shallow water habitat still remained. Care should be taken during dredging efforts to limit the amount of fine sediment re-suspended to assure that impacts to adjacent seagrass beds would be minimized. A Biological Assessment should be prepared for these species and formal consultation with USFWS will be required pursuant to Section 7 requirements.

5.0 DREDGED MATERIAL DISPOSAL OPTIONS

The following dredged material disposal options are presently being considered as part of the overall study. Since it is presently unknown as to the preferred option(s) and/or combination of options to be selected, a detailed impact analysis without information such as volume of material, hauling/pumping methods, pumping distance, and pipeline corridor location cannot be completed. General assessments of probable impacts on marine resources are provided below.

5.1 Offshore Dredged Material Disposal Site (ODMDS)

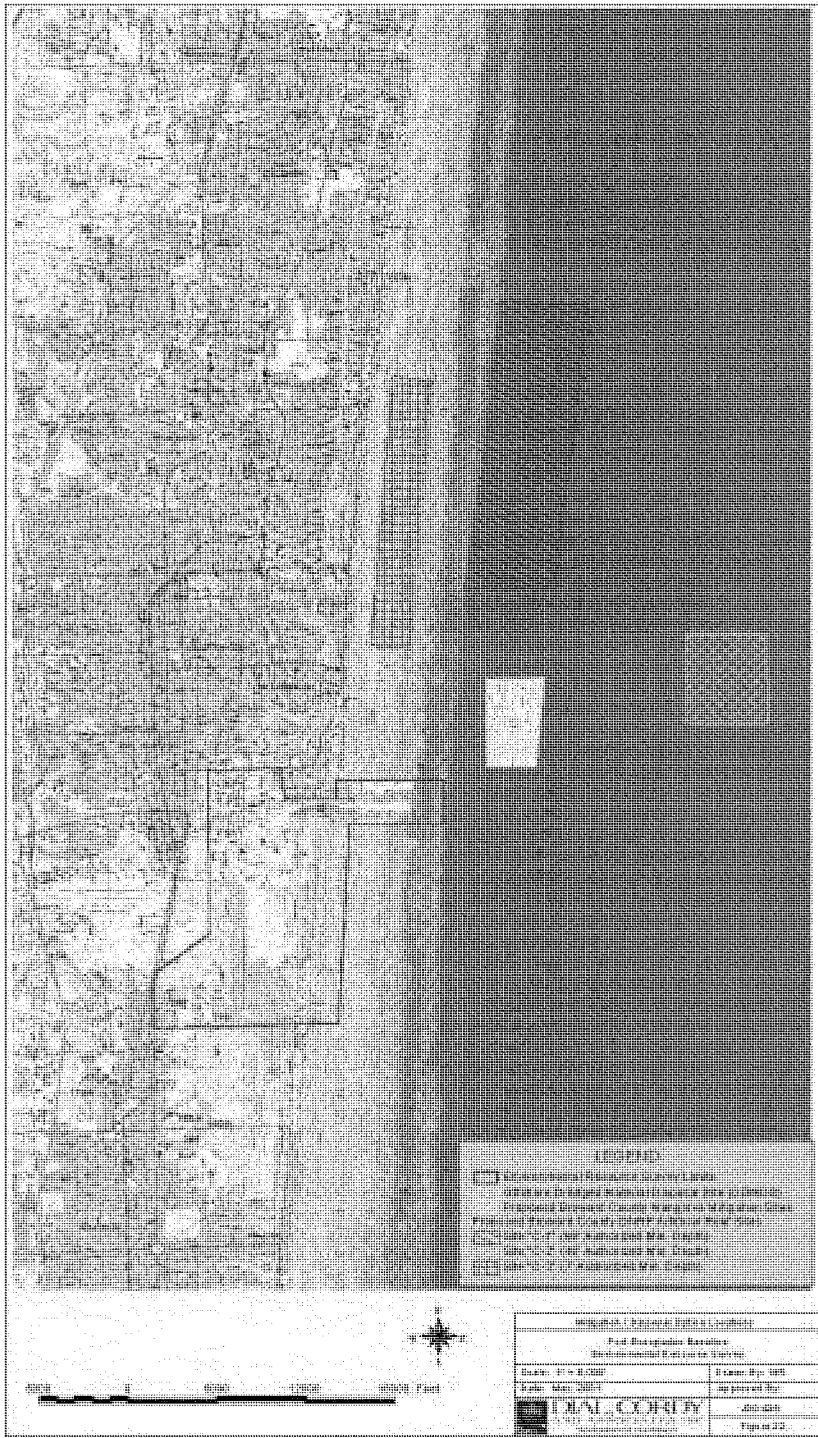
A new ODMDS is presently being designated by EPA and the Corps of Engineers for disposal use (Figure 22). Since a draft EIS is being prepared by the Corps of Engineers, impacts for use of this site will not be addressed in this document. It is anticipated that the site will be approved for use in 2002 and can be considered a viable site for disposal of material unsuitable for other uses.

5.2 Beach Placement

It is anticipated that approximately six million cubic yards of dredged material could be placed on the beach at John U. Lloyd State Park. However, due to the amount of limestone rock it is anticipated that the material would have to be processed on land prior to placement on the beach. Assuming that the material could be processed to create beach quality sand suitable for sea turtle nesting and that the material would be placed above the MLW line, there would be only temporary impacts to the benthic community associated with the sandy beach and the epibentic invertebrates and fish associated with the nearshore hardbottom habitat. Due to the small amount of material expected to be available for beach placement, and minimal extension of the tow of fill, no permanent impacts to marine resources are anticipated. With typical seasonal restrictions on beach fill and good Best Management Practices (BMPs) to minimize turbidity and sediment transport offshore, no long-term impacts are expected.

5.3 Airport Stockpile

The Airport is studying the option to allow the port to permanently temporarily store and use dredged material at the east end of the runway. No wetlands or protected species occur in this area. As long as the material is contained in a diked disposal area and BMP's are adhered to prevent erosion and runoff following storm events and dewatering, use of this site is not expected to have temporary or long-term adverse impacts.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5.4 Beneficial Uses for Habitat Creation and Restoration

Dredged material has long been considered and used to create and restore natural ecosystems. If material were suitable for habitat creation in West Lake Park and the county's master plan for the park would support use of the material a small amount could be used to create shallow water habitat suitable for mud flats, and seagrass natural recruitment and or planting. Negative impacts associated with the use of the material on existing marine resources within West Lake open water areas associated with use of the material would be minor as long as pipelines are carefully placed to minimize impacts to existing mangrove habitat and appropriate turbidity controls are adhered to when placing the material in the deeper areas of the estuarine embayment.

6.0 COMPENSATORY MITIGATION OPTIONS

This section outlines available options for providing compensatory mitigation for unavoidable impacts to mangrove, seagrass, unvegetated bottom, and offshore hardground/reef habitats potentially impacted by implementation of study elements considered in this document. Since the preferred suite of study elements to be combined have yet to be decided upon, only ranges of impacts are available for defining mitigation requirements and needs (Table 8). If one assumes combining one alternative from each element, the range in impacts (low to high) would include 3.44 to 4.77 acres of seagrass habitat, 32.48 to 41.39 acres of mangrove habitat, 17.48 acres of reef habitat, and 16.1 acres of deeper unvegetated rubble and sand/silt bottom located in the channel. Of these impacts, mitigation would be required for seagrass, mangrove, and reef /hardbottom habitats where new construction or dredging is proposed. All of these habitat types are considered EFH by the SAFMC and NMFS (SAFMC 1998). For dredging the rubble and silt/sand bottom within the channel, mitigation would not be required since dredging was previously performed in the channel and mitigation should not be required.

In addition to the impacts identified above, up to two acres of the mangrove habitat were previously restored as mitigation for past impacts. Mitigation required for this area would include compensation for taking the created mangrove area and for impacting it a second time for the proposed project. In the event land is taken on State owned park land, compensation will also be required above and beyond what is required for mitigation of wetland impacts. Once a decision is made relative to the recommended plan, these combined impacts can be further quantified.

6.1 Mitigation Policies

A summary of mitigation programs and policies in effect by federal reviewing agencies, including the EPA, USFWS, and NMFS, are provided below.

U.S. Environmental Protection Agency Mitigation Policy

Policy regarding mitigation under the Clean Water Act (CWA) Section 404(b)(1) guidelines were expressed within a Memorandum of Agreement (MOA) between EPA and the USACE and became effective February 7, 1990. The purpose of the MOA is to provide guidance to determine appropriate and practicable mitigation under the Section 404 Regulatory Program. Practicable is defined as "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purposes."

According to the MOA, on-site mitigation is preferable to off-site mitigation. Similarly, in-kind mitigation is preferable to out-of-kind mitigation. However, EPA may accept off-site or out-of-kind mitigation if it is the most practicable solution. EPA expressed a preference of restoration of wetlands over creation of wetlands from upland habitat for two reasons. First, EPA considers the likelihood of success higher for restored wetlands than for created wetlands. Second, EPA is concerned about the reduction of potentially valuable uplands resulting from the mitigation.

The MOA states that the objective of mitigation for unavoidable impacts is to offset environmental losses. Mitigation should provide, at a minimum, one for one functional replacement (i.e., no net loss of wetland value), with an adequate margin of safety to reflect the expected degree of success, but this requirement may not be appropriate and practicable in all cases. A minimum of 1:1 acreage replacement may be used as a reasonable surrogate for no net loss of functions and values where definitive information is lacking. However, this ratio may be greater where the wetland being impacted is high and the replacement wetlands are of lower functional value or the likelihood of success is low. Conversely, the ratio may be less than 1:1 for areas where the wetland being impacted is low and the likelihood of success associated with the mitigation proposal is high.

U.S. Fish and Wildlife Service Mitigation Policy

The U.S. Fish and Wildlife Service Mitigation Policy (January 23, 1981) established policy for USFWS recommendations on mitigating the adverse impacts of land and water developments on fish, wildlife, and their habitats. According to the policy, compensation may be accepted for wetland impacts in a variety of ways. Mitigation activities may include: wildlife management activities, habitat construction activities, fishery propagation, protective designations on public lands, buffer zones, property leases, wildlife easements, water right acquisition, and fee title acquisition. Compensatory mitigation actions should only occur after all efforts to avoid and minimize impacts have been utilized. USFWS policy states that appropriate mitigation for unavoidable wetland impacts are based on the resource value of the potential impacted wetland. Four categories of resource value have been defined by the USFWS for which different levels of mitigation may be determined.

A wetland classified as resource category 1 consists of high value wetland that is unique and irreplaceable on a national basis or in the eco-region. For this category, no loss of existing habitat value is the goal, and the USFWS will recommend that all losses of existing habitat be prevented.

A resource category 2 wetland is of high value and relatively scarce on a national basis or within the eco-region. For this category, the USFWS maintains a goal of no net loss of in-kind value. If unavoidable loss is likely to occur, in-kind replacement will be the recommendation. An exception to this rule may occur where the out-of-kind replacement is of greater value than the habitat to be impacted, or in-kind replacement is not physically or biologically obtainable in the region.

A resource category 3 wetland is of high to medium value and is relatively abundant on a national basis. The USFWS mitigation goal is no net loss of habitat value while minimizing loss of in-kind habitat value. For impacts to resource category 3 wetlands, in-kind replacement is preferred. If in-kind replacement is not practicable, out-of-kind creation or restoration, or increased management of replacement habitat that increases the value of the existing habitat can achieve mitigation goals.

A resource category 4 wetland is of medium to low value, with a goal of minimum loss of habitat value. Compensatory mitigation for unavoidable losses to resource category 4 wetlands may be required,

National Marine Fisheries Service

As described in the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), the EFH provisions of the act support one of the nation's overall marine resource management goals – maintaining sustainable fisheries.

The focus of the mitigation policy is to conserve and enhance EFH and to avoid, minimize, or compensate for impacts to EFH due to development activities. As with the other federal agency policies, the primary goal of any action is to avoid impacts to natural resources. However, if impacts to these resources are unavoidable, compensatory mitigation may be required. When unavoidable impacts to EFH occur, the NMFS will recommend mitigation measures to compensate for any loss of resource value. Recommendations may include: restoration of riparian and shallow coastal areas (i.e., re-establishment of vegetation, restoration of hardbottom characteristics, removal of unsuitable material, and replacement of suitable substrate), upland habitat restoration, water quality improvement or protection, watershed planning, and habitat creation. The preferred type of mitigation is enhancement of existing habitat, followed by restoration, and finally creation of new habitat.

Mitigation should focus on the replacement of lost habitat and associated values attributed to the habitat and toward maintaining sustainable fisheries. In particular, mitigation should be targeted toward impacts as a result of the proposed action (see Section 4.0) to the listed managed species discussed in Section 3.2.4.

Mitigation for EFH should focus on the replacement of lost habitat and associated values attributed to the habitat and towards maintaining sustainable fisheries. Since no definitive policy on mitigation is currently available on mitigating EFH impacts, development of mitigation strategies is subjective and somewhat difficult to address. Therefore, mitigation for EFH impacts must focus on strategies that enhance fisheries production and help ensure the sustainability of fisheries. Creation of mangrove habitat and mud flats, enhancement of fisheries resources by creating shallow water habitat or artificial structures, restoration of SAV habitat where feasible, and preservation of environmentally sensitive waterfront land threatened by development are all viable options that can compensate for impacts to EFH, and have been used and accepted elsewhere.

Mitigation requirements for EFH impacts, associated with proposed dredging of existing channels and basins, are difficult to define. While these areas will see a temporary loss of benthic production, all the affected areas will see recruitment of the benthic community, followed by fish utilization of the habitat. All of these dredged areas will continue to provide food chain support and act as functional EFH habitat, including the turning basins, terminals and inner and outer entrance channels. Since the existing harbor basin provides seasonal fishery habitat, we would expect the proposed basin to likewise provide comparable habitat.

6.2 Mitigation Options

Compensation options for unavoidable impacts to coastal and marine habitats associated with implementation of the study elements are limited to those within the tidal influence of the Port Everglades entrance channel, including the West Lake property and land west of the Port property up the DCC. Other options would be considered off-site and as such may not be allowed by Broward County or would require a higher mitigation ratio.

6.2.1 West Lake

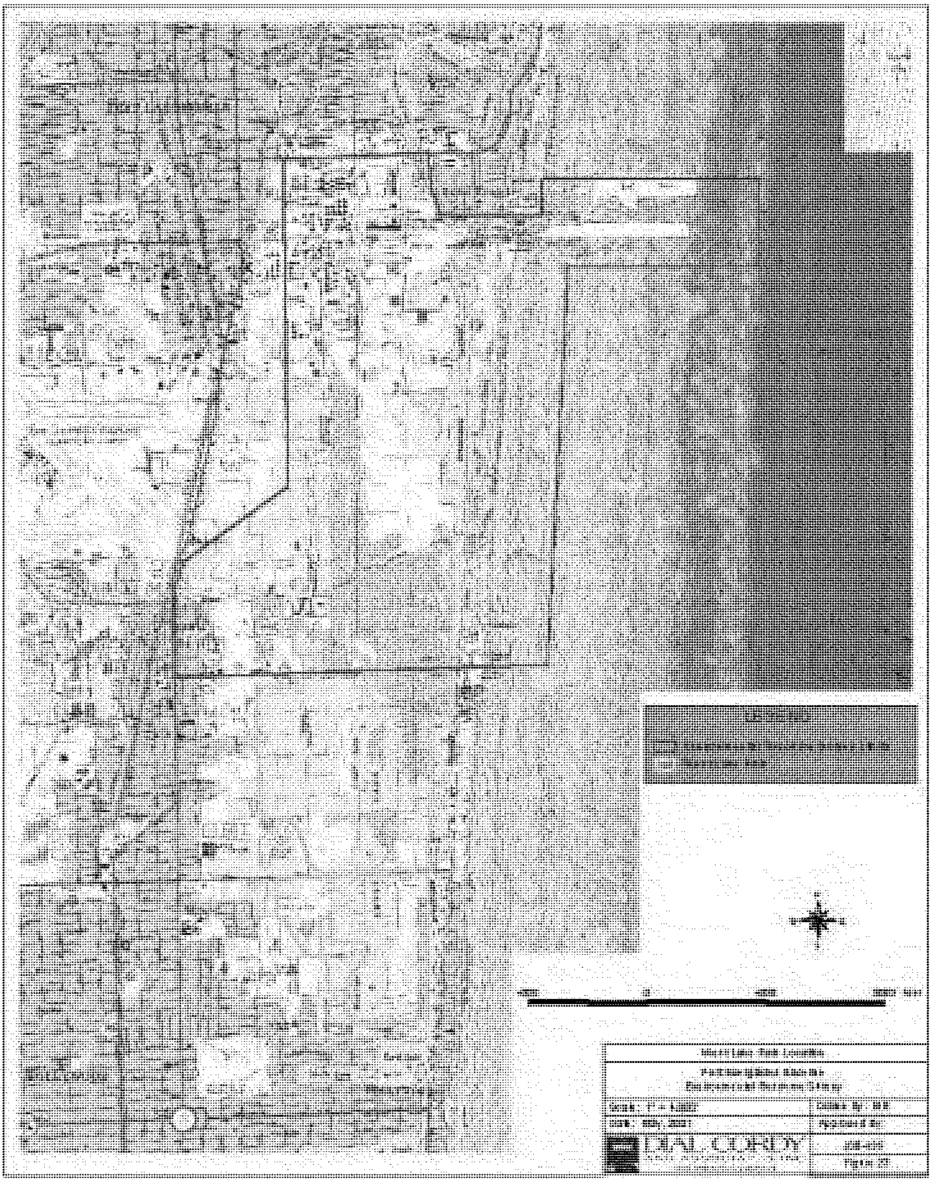
A West Lake Master Mitigation Plan is presently being developed by Broward County with the support of the Aviation, Parks and Recreation and Port Everglades Departments to restore and enhance wetlands and other ecosystems on the subject property (Figure 23). Mitigation options on the West Lake Park property will conform with the approved master plan under development and following agency concurrence. Following the approved agreement with the agencies on the proposed plan and credit values, the Port and airport will split the available values. It is anticipated that the plan will be approved by March 2002. A summary of conceptual creation, restoration, enhancement and acquisition opportunities are described below.

Mangrove Creation, Restoration and Enhancement Options

As conceptually proposed, the plan will include the creation, restoration and enhancement of mangrove wetlands through the eradication of exotic and nuisance vegetation, the re-grading/scraping down process and the planting of historically filled areas on 55 acres: in addition to creating other shallow water habitat such as mudflats. The plan may also include shoreline stabilization to provide more area for natural mangrove recruitment and creation of more tidal ditches to promote improved tidal flushing and water quality.

Shallow Water Habitat Restoration (seagrass and mudflats)

Opportunities to restore shallow water habitat suitable for the propagation of submerged aquatic vegetation are also being considered by Broward County, including planting seagrass in the shallow areas of West Lake and adjacent to the AIWW. One option recommended would be to use suitable dredged material from the DCC to fill deeper areas in West Lake, thus bringing the bottom elevation up to depths where light penetration is adequate to support SAV. Seagrass impacted from the AIWW channel could be transplanted within the filled



areas of West Lake prior to AIWW channel dredging. Based on review of aerial photographs of West Lake and discussions with Port Everglades staff (personal communication, Allan Sosnow, Port Everglades), it is possible that there are areas within the West Lake embayment that could be restored or enhanced through raising the bottom elevation and or planting submerged aquatic vegetation. Since bathymetric data is presently not available for West Lake Park the exact area available is unknown. Information required to assess the feasibility of restoration would include bathymetric mapping of West Lake open water areas, mapping of existing seagrass beds in West Lake, evaluation of existing sediment characteristics in potential areas of West Lake where restoration could occur and of available dredged material from DCC. In addition, photosynthetically active radiation (PAR) and salinity data for potential restoration areas in West Lake and from seagrass donor sites in the AIWW would be required. Following acquisition of this data a more thorough evaluation can be made and a detailed restoration plan prepared.

Land Acquisition and Preservation

To further enhance and protect ecological values in West Lake Park, a number of privately owned out-parcels are under consideration for acquisition as part of the overall master plan of West Lake Park. Protection of these parcels would provide more area for habitat restoration and enhancement in addition to providing a buffer from adjacent developed land. The acquisition of these parcels would help improve water quality throughout the park property. Assisting in acquisition of these parcels could serve to offset impacts associated with the taking of land from John U. Lloyd SRA.

6.2.2 Dania Cutoff Canal Property

Based on review of available aerial photography, there are other parcels of land located upstream of the port property in the DCC that are old agricultural lands adjacent to the DCC. These sites, if not contaminated or already planned for development, appear suitable for creating mangrove and shallow water habitat.

6.2.3 Florida Power & Light Everglades Mitigation Bank

This mitigation bank is operated by Florida Power & Light Company and readily sells credits for mitigation associated with mangrove impacts. This site is located in south Dade County and would be considered out of Broward County and off-site in terms of use, however, based on discussions with bank personnel (personal communication, Steve Collins, Everglades Mitigation Bank) Broward County is within the allowable service area for the mitigation bank. Presently, credits sell for $45,000/credit for freshwater herbaceous credits and $75,000/credit for mangrove and other saltwater credits. However due to the distance from the Port, it is probable that the credits required would be higher. Use of the bank would require concurrence from the state and federal resource agencies. A determination of the credits needed to supplement the overall required mitigation for mangrove impacts will require conducting a functional assessment of the mangroves to be impacted. It is recommended that the bank be considered a supplemental source of mitigation credits in the event impacts cannot be fully mitigated for in the county.

6.2.4 John U. Lloyd SRA Mangrove and Shallow Water Habitat Replanting

In the event that study element 5b is included in the final plan, the shallow shelf excavated for widening could be replanted with mangroves. Mangroves could be removed from the area prior to dredging and stockpiled until construction is done, with some being used for replanting purposes. The remaining mangroves could be relocated and planted in restoration areas in West Lake Park. This would be considered on-site mitigation, as the West Lake property is adjacent to the Port.

6.2.5 Offshore Artificial Reef Placement

The implementation of either study element alternative S-1A or S-1B would impact 0.58 acres of reef community. This impact would result from the removal of this habitat with the associated widening and deepening of the OEC. To mitigate for this, artificial reef material can be placed in areas offshore to recreate reef habitat. Sites recommended for artificial reef creation by Broward County (personal communication, Ken Banks, Broward County DNRP) are shown in Figure 22. In addition to the creation of this habitat, a monitoring component can be added to the reef construction to assess the effectiveness of the reef material in creating habitat. Monitoring of artificial reefs and adjacent reefs will gauge the effectiveness of this option.

6.3 Effectiveness of Available Mitigation Options

A review of the effectiveness of each proposed mitigation treatment is summarized below.

6.3.1 Mangrove Restoration and Creation

Mangrove habitat has been successfully restored in the past. Restoration and rehabilitation have long been recommended for areas that have been altered or in areas where mangrove habitat cannot self-correct. Restoration of habitat is better in many cases than creating habitat. In areas where habitat is restored, natural recovery of mangrove habitat would offer the best mitigation options. The reestablishment of this habitat would occur if normal tidal hydrology is not interrupted and there are available stocks of adjacent mangroves. In the event that natural restoration could not occur creation of mangrove habitat would be another option. Planting of mangrove habitat would be adequate in areas where mangrove stocks would not normally reestablish. This option should only be exercised if natural recruitment would not occur.

6.3.2 Seagrass Restoration

Restoring seagrass beds, if successful, can be an appropriate mitigation strategy due to their high ecological value and declining abundance. Seagrass restoration adds habitat value to unvegetated sand or mud substrates. The addition of seagrass beds increases the productivity and diversity of the unvegetated bottom, which can directly compensate for the historic loss in productivity and diversity.

Fonseca et al. (1996a, 1996b) found that within two years, restored seagrass beds (*H. wrightii*) planted on 0.5-m centers reach the same areal density and support animal densities, number of taxa, and species composition equivalent to natural beds. Some restored seagrass beds support invertebrate populations that are as or more abundant than those in natural grassbeds (Bell et al. 1993). Restored seagrass beds appear to be as suitable as natural seagrass beds for juvenile and small adult fish (Brown-Peterson et al. 1993).

Restored seagrass beds support animal densities similar to natural seagrass beds when shoot density is only one-third that of a natural seagrass bed (Fonseca et al. 1996). Thus, the habitat value of a restored seagrass bed is maximized relatively quickly, prior to the restored bed reaching the same vegetative density as a natural seagrass bed. In addition to providing habitat itself, seagrass beds increase the productivity of adjacent habitats. Irandi and Crawford (1997) found that the presence of seagrass beds adjacent to tidal marshes increased the abundance and growth rates of fish in the tidal marsh.

Research has identified that seagrass beds are more diverse and productive than unvegetated substrate. Average fish densities in natural seagrass beds were ten times greater than those on unvegetated areas (~20 individuals/m^2 versus 1.74 individuals/m^2). Shrimp densities in natural shoal grass beds averaged 151 individuals/m^2 compared to 3.02 individuals/m^2 in unvegetated areas. Crab densities in natural seagrass beds were 20 to 50 individuals/m^2 compared to an average of 1.91 individuals/m^2 on unvegetated areas (Fonseca et al. 1996). Within 1.5 years of planting, restored seagrass beds support shrimp, fish, and crab densities similar to natural seagrass beds (Fonseca et al. 1996). Thus, restored seagrass beds can increase the density of shrimp, fish, and crabs by 10 to 50 times compared to unvegetated substrates.

Although research has identified that seagrass beds are more diverse and productive than unvegetated substrates, relatively few studies compare secondary productivity between seagrass beds and other habitats. Heck et al. (1995) determined that eelgrass beds in the northeast had macroinvertebrate production 5 to 15 times higher than adjacent unvegetated habitats. At least a similar increase in productivity is expected for shoalgrass and turtlegrass, which have a higher primary productivity than eelgrass. Also, a similar increase in abundance, diversity, and productivity of fish species may also be expected.

Based on the scientific literature, a compensation ratio of two-acres of seagrass as compensation for one acre of impact is conceptually valid. This ratio acknowledges the increase in abundance, diversity, and productivity as a result of planting seagrass in existing unvegetated areas, as well as the increase in abundance and diversity of adjacent habitats. However, without guaranteed success and with the known high mortality of seagrass plantings (Fonseca et al. 1998), the resource agencies concern that this ratio is too low is valid. Should experimental seagrass restoration efforts prove that over 50% success can be achieved, then this ratio may be acceptable.

Restoration of seagrass communities, while still considered experimental and not highly successful by resource agencies, can enhance habitat heterogeneity and the diversity of invertebrate and fish communities, if carefully implemented. While seagrass restoration is an acceptable form of mitigation, none of the three commenting federal agencies are likely prepared to readily accept a form of mitigation that cannot be guaranteed. The recent treatise on seagrass restoration entitled "Guidelines for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters" by Fonseca et al. (1998) discusses the benefits and risks associated with seagrass restoration. Given the documented success of more recent efforts to restore seagrass communities, restoration is quickly becoming a proven resource management tool in some areas where conditions are appropriate.

To achieve success in restoring seagrass communities, proper site selection, selection of planting techniques, care in installation of planting units, and incorporation of plant demography into the planning process must be strongly understood and adhered to by resource mangers responsible for designing, funding, and construction. The lack of standard assessment techniques following planting has made evaluation of restoration success quite difficult (Race and Fonseca 1996). However, seagrass plantings that persist over multiple years and generate the target acreages have been shown to quickly provide functional attributes associated with natural seagrass beds.

6.3.3 Artificial Reef Construction

Currently there are many options for the construction of artificial reefs. Methods used previously have included limestone boulders, concrete tetrahedrons, and Reef Balls™, among others. Broward County currently prefers the use of limestone boulders as the material for artificial reef construction (personal communication, February 5, 2001, Ken Banks Broward County Biological Resources Division). Currently there are three locations off shore of Broward County that may be utilized for artificial reef creation (Figure 22). These areas occur in water depths of 12 feet to over 400 feet MLW. Placement of limestone material in any or all of these areas would provide suitable habitat replacement for the loss of reef associated with widening and deepening.

6.3.4 Land Acquisition and Preservation

The purchase and preservation of ecologically valuable land adjacent to existing public lands or preserves is a viable and time accepted method of supplementing overall mitigation programs. While it is not the preferred method of compensation by most if not all resource agencies, it can provide considerable benefits to existing wetlands and as buffers for proposed restoration and enhancement areas. Benefits include providing vegetative buffers from developed areas, improving water quality in receiving waters, and providing access for recreational purposes. In many cases land acquisition includes purchasing land for restoration or enhancement purposes, whereby the purchased properties are placed in conservation.

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APPENDICES

Appendix A

Sources of Information

Appendix A: List of Persons Consulted

Name	Affiliation	Information
Allan D. Sosnow	Port Everglades, Department of Broward County	Wetland map, general resource information, overall project plan
Charles G. Messing, Ph.D.	Nova Southeastern University	Benthic community data
Kurt J. Volker	Broward County Commission, Parks and Recreation Department	West Lake Park Management Plan
Gill MacAdam	Broward County Commission, Parks and Recreation Department	West Lake Park Management Plan
David Stout	Broward County Commission, Department of Planning and Environmental Planning	Turtle Monitoring Reports, Fish inventories
Pam Fletcher	Broward County Commission, Department of Planning and Environmental Planning	Manatee data
Lou Fisher	Broward County Commission, Department of Planning and Environmental Planning	Coral Reef data
Mike Johnson	National Marine Fisheries Service	Seagrass information
Chris Creed	Olsen and Associates	Reef Maps
Steve Dale	Florida Department of Environmental Protection, John U. Lloyd State Park	Park management plan
Ephrat Yovel	Florida Department of Environmental Protection, Park Planning	John U. Lloyd Draft Management Plan
Delores Smith	Fort Lauderdale/Hollywood International Airport	Information on Airport Expansion and maps of property
Steve Higgins	Broward County Commission Department of Planning and Environmental Protection (DPEP) Biological Resources Division	Coral Reef Mapping and County Resource Reports
Ken Banks	Broward County Commission DPEP	Artificial Reefs
Mike Knoll	Miller Legg	Final Mitigation Plan for Port
Mark Thompson	National Marine Fisheries Service	Seagrass information, information on blasting effects to wildlife
Richard Dodge, PhD.	NOVA University	Benthic Mapping and Monitoring
David Burnhart	NMFS	Effects of Blasting References
Carol Knox	Florida Fish and Wildlife Conservation Commission	Manatee Data
John Meshaw	Wilmington District USACE	Blasting Effects Study
Frank Yelverton	Wilmington District USACE	Blasting Effects Study
Bill Adams	Wilmington District USACE	Blasting Effects Study
Steve Collins	Everglades Mitigation Bank	Mitigation Options

Appendix B

Florida Natural Area Inventory Listed Species
Broward County

Florida Natural Area Inventory Listed Species, Broward County

Available at the Jacksonville District U.S. Army Corps of Engineers Office

Appendix C

Survey Photographs


Photo 1: Parrotfish and wrasse in sea whip along reef transect.

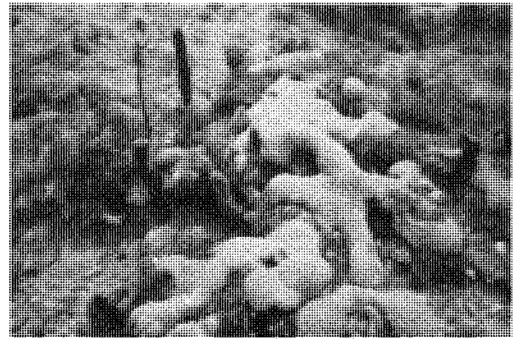
Photo 2: Representative hard coral along transect.

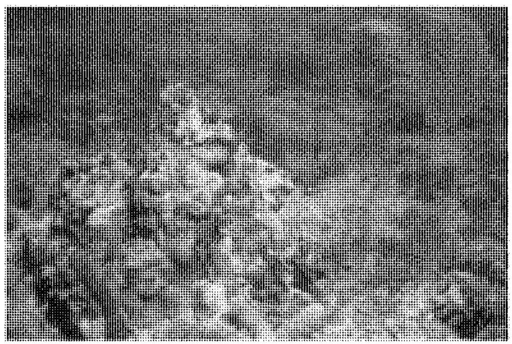
Photo 3: Colony of Christmas tree worms along reef transect.


Photo 4: Coral and sponges representative of transect along nearshore reef area.

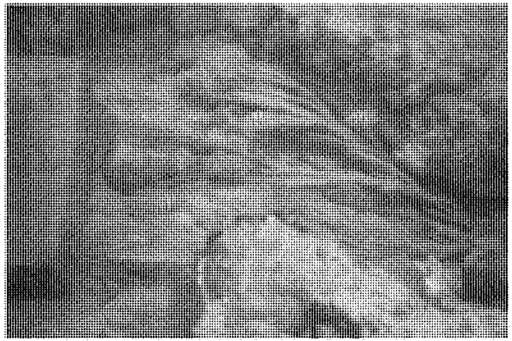

Photo 1: Octocoral and sargeant majors along reef transect nearshore.

Photo 2: Representative staghorn coral and gorgonians along nearshore transect.

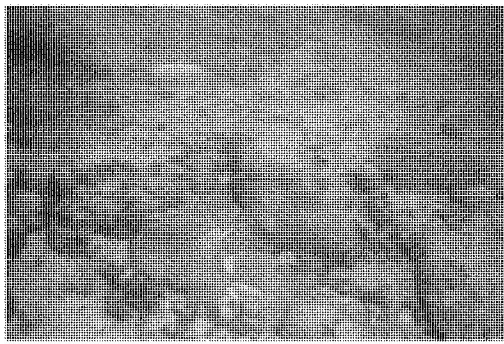

Photo 3: Stony corals representative of nearshore transect.

Photo 4: Seafan and stony corals along nearshore transects.

Appendix D

Seagrass Field Data Sheets (2000 Survey)

Transect	Total Quadrat	Occupied Quadrats	Sub Units	Occupied Sub Units	Sum Cover Score	Species	Frequency	Abundance	Density
PE1	4	2	64	6	0.6	HD	0.0938	0.3000	0.1500
PE2	4	2	64	22	2.5	HD	0.3438	1.2500	0.6250
PE3	4	1	64	1	0.1	HD	0.0156	0.1000	0.0250
PE6	6	2	96	6	0.6	HD	0.0625	0.3000	0.1000
PE8	4	1	64	5	0.5	HD	0.0781	0.5000	0.1250
PE10	7	1	112	4	0.1	HD	0.0357	0.1000	0.0143
PE12	6	3	96	3	0.3	HD	0.0313	0.1000	0.0500
PE14	8	1	128	8	0.5	HD	0.0625	0.5000	0.0625
PE1A	4	4	64	31	5	HD	0.4844	1.2500	1.2500
PE2A	7	5	112	75	17	HD	0.6696	3.4000	2.4286
PE3A	4	1	64	11	2	HD	0.1719	2.0000	0.5000
PE4A	2	1	32	16	5	HD	0.5000	5.0000	2.5000
PE5A	4	2	64	13	1.1	HD	0.2031	0.5500	0.2750
PE6A	4	2	64	25	5	HD	0.3906	2.5000	1.2500
PE7A	3	1	48	10	1	HD	0.2083	1.0000	0.3333
PE8A	4	2	64	2	0.2	HD	0.0313	0.1000	0.0500
PE9A	7	5	112	47	6.1	HD	0.4196	1.2200	0.8714
PE6	6	2	96	11	2.1	HJ	0.1146	1.0500	0.3500
PE7	5	2	80	14	1.1	HJ	0.1750	0.5500	0.2200
PE8	4	1	64	3	0.1	HJ	0.0469	0.1000	0.0250
PE12	6	3	96	14	2.6	HJ	0.1458	0.8667	0.4333
PE13	5	1	80	14	2	HJ	0.1750	2.0000	0.4000
PE14	8	2	128	4	0.2	HJ	0.0313	0.1000	0.0250
PE1A	4	1	64	16	4	HJ	0.2500	4.0000	1.0000
PE5A	4	1	64	16	3	HJ	0.2500	3.0000	0.7500
PE9A	7	2	112	13	4	HJ	0.1161	2.0000	0.5714
PE2A	7	3	112	27	2.5	HW	0.2411	0.8333	0.3571
PE13	5	2	80	18	2	HW	0.2250	1.0000	0.4000
PE14	8	1	128	2	0.1	HW	0.0156	0.1000	0.0125
PE5A	4	2	64	30	3	HW	0.4688	1.5000	0.7500
PE8A	4	1	64	2	0.1	HW	0.0313	0.1000	0.0250
PE9A	7	3	112	16	4.1	HW	0.1429	1.3667	0.5857
PE4									
PE5									
PE9									
PE11									

HD Overall Frequency	HD Overall Abundance	Overall Density
0.2237	1.1865	0.6241
HJ Overall Frequency	**HJ Overall Abundance**	**Overall Density**
0.1450	1.5185	0.4194
HW Overall Frequency	**HW Overall Abundance**	**/ Overall Density**
0.1874	0.8167	0.3551

Appendix E

Bird Species List
Broward County

Bird Species List, Broward County

Available at the Jacksonville District U.S. Army Corps of Engineers Office

Appendix D

D-2

Benthic Assessment

Benthic and Fish Community Assessment At Port Everglades Harbor Entrance Channel

FINAL DRAFT

Prepared for
Jacksonville District
U.S. Army Corps of Engineers
701 San Marco Blvd.
Jacksonville, FL 32207

by
Dial Cordy and Associates Inc.
490 Osceola Avenue
Jacksonville Beach, FL 32250

December 2009

EXECUTIVE SUMMARY

The Jacksonville District U.S. Corps of Engineers (USACE) is conducting a feasibility study in part to evaluate the widening and deepening of the Outer Entrance Channel (OEC) of Port Everglades Harbor (Broward County, Florida). The proposed improvements would impact offshore marine biological resources, including reef communities offshore of the port. Dial Cordy and Associates Inc. (DC&A) was contracted by the USACE to map existing benthic habitats and quantitatively assess population levels of reef biota, particularly sessile organisms (i.e., macroalgae, sponges, octocorals, and hard corals) and reef fish associated with the two north-south oriented, parallel reef tracts that are likely to be directly or indirectly impacted by OEC improvements. The habitat equivalency assessment and mitigation required for these proposed impacts will be addressed in the Habitat Equivalency Assessment (HEA) Report and the Mitigation Plan.

Investigations involved study sites located on the outermost two of three, shore-parallel fossil reefs that support modem sponge, octocoral and coral communities in water depths ranging from approximately 8 to 21 meters (m). These fossil reefs were elkhorn coral communities which were drowned by sea level rise 5000 to 7000 years ago. The outermost reef is here referred to as the "outer reef," or "third reef. The "middle reef" is also referred to as the "second reef." Neither the innermost shore-parallel fossil reef (inner reef) nor the shoreward hardbottom zone was investigated for this study since the scope of work did not include these areas

During February and March 2006, a total of 41 sampling stations were assessed on the second and third reefs. Sampling sites included areas both within and adjacent to the footprint of the proposed OEC improvements on the second reef (Reef 2 (R2)) and third reef (Reef 3 (R3), R3-PI, and R3-C). Benthic organisms were assessed along belt transects using *in situ* visual assessments of benthic organisms, underwater videography, and *in situ* visual observations of reef fish. Individual belt transects were 10 m long and 1 m wide for the *in situ* visual assessments, and 10 m long and 40 centimeters (cm) wide for video transects. The dimensions of the belt transects were based on methods applied to coral habitats in Florida and the Caribbean province (e.g., Loya 1976; Rogers et al. 1983; Liddell et al. 1984; Aronson and Precht 1995). Parameters used to characterize the benthic organisms from visual surveys included scleractinian (hard coral) species diversity (*H'*), species richness, and colony density. *In situ* data collected for octocorals and sponges were taken to the lowest possible taxonomic level. Videographic surveys yielded information on the percent cover of scleractinians, octocorals, hydrocorals, macroalgae, turf algae, unconsolidated sediments, and rubble on the seafloor. Species richness was also evaluated from the videographic transects. Fish censuses included stationary counts and counts conducted along belt transects which provided estimates of fish species richness, abundance, and size.

Sites surveyed within and adjacent to OEC improvements were low in live cover of benthic organisms including corals, octocorals, and sponges, while bare space and turf algae were abundant. These results are similar to some comparative sites (e.g. BC2 and BC3 from Gilliam 2007). With respect to octocoral and sponge density and cover, the lower values found at R2, R3, R3-PI, and R3-C may be related to inlet water quality issues (Griffin and Lipp 2009; Reich et al. 2009) and mechanical damage due to anchoring and other impacts associated with a channel that serves commercial as well as recreational users.

Analyses of collected data showed many differences between the biota of the third and second reefs. Third reef sites (R3, R3-PI, and R3-C) were more developed biologically compared to R2. Third reef sites supported greater hard coral colony densities, coral cover, and octocoral colony densities. The analyses of the data collected for this study corroborated Gilliam et al.'s (2006) assessments of the differences between second and third reef benthic communities.

Reef 3 (R3) was located within the proposed OEC extension area. Site substrates at R3 consisted of hardbottom, rubble, rocks, pockets of coarse and fine sand, and few artificial substrates. Less than 3 percent (%) of the scleractinians observed at R3 had some form of bleaching or coral mortality; species most affected were *Siderastrea siderea*, (massive starlet coral), and *S. intersepta,* (blushing star coral).

Two species of coral, *Acropora palmata* (elkhorn coral) and *A. cervicornis* (staghorn coral), found off Broward County are listed as threatened species under the Endangered Species Act of 1973 (ESA), as amended (50 CFR Part 223). During field reconnaissance and quantitative surveys in February and March 2006, neither of these species were observed within study sites.

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1.0 INTRODUCTION

1.1 Study Context and Objectives

The Jacksonville District U.S. Corps of Engineers (USACE) is conducting a feasibility study to evaluate the widening and deepening of the Outer Entrance Channel (OEC) of Port Everglades Harbor (Broward County, Florida). The proposed OEC improvements would impact offshore reef communities associated with two shore-parallel fossil reefs. Mapping of these reef habitats and a quantitative assessment of affected biota was required to determine the biological community characteristics of possible impact areas. The *amount* and *type* of mitigation required, should the project result in unavoidable impacts, will be calculated using these data, but will be addressed in a separate Habitat Equivalency Assessment (HEA) Report and Mitigation Plan.

The USACE contracted Dial Cordy and Associates Inc. (DC&A) to map benthic habitats and assess population levels of reef biota using standardized survey techniques. The principal objective of the study was to quantitatively describe, using parametric and non-parametric statistics, the sessile organisms (i.e., macroalgae, sponges, octocorals and hard corals) and reef fishes associated with the two fossil reefs that are likely to be directly or indirectly impacted. Study sites included reef habitats within, adjacent to, and south of, the area subject to proposed OEC improvements (see "Dredge Limits of Proposed Outer Entrance Channel" in Figure 1).

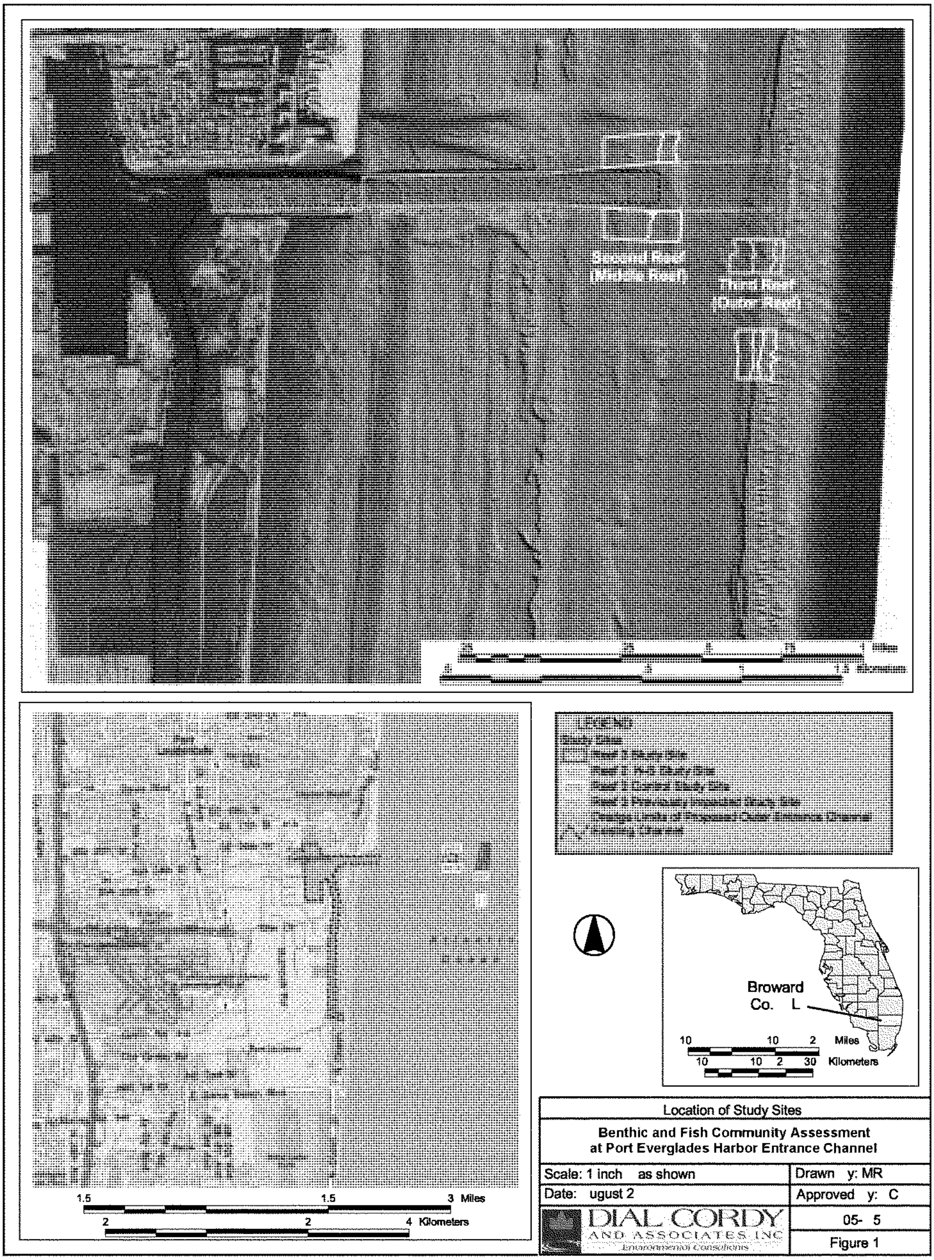
1.2 Study Area

The reef tracts of southeast Florida (Miami-Dade, Broward, and Palm Beach counties) are considered high-latitude reefs, existing near the northern limit of reef growth in the continental Unites States (e.g., Goldberg 1973). The study area was located on a portion of the reef complex that lies seaward of Port Everglades, Broward County, Florida (see Goldberg 1973; Moyer et al. 2003; Gilliam et al. 2004 and 2006; Banks et al. 2007). The complex is comprised of a nearshore hardbottom zone and a seaward succession of three shore-parallel reefs referred to as the "inner," "middle, and "outer" reefs, or the "first," "second", and "third" reefs, respectively (Goldberg 1973; Moyer et al. 2003; Gilliam et al. 2004, 2006; Banks et al. 2007). This reef system is established on mid-Holocene fossil-reefs, formed by elkhorn coral communities that were subsequently drowned by sea level rise between 5000 and 7000 years ago (Lighty et al. 1978). The reef-fossil substrates currently support modern biological communities consisting of Caribbean fauna (Moyer et al. 2003; Giliam et al. 2004, 2006). Surveys for this study were conducted on the two outermost fossil reefs (middle and outer reefs) in water depths ranging from approximately 8 to 21 m. In this report, the outer reef is also refered to as "third reef," and the middle reef as "second reef." Neither the shoreward hardbottom zone nor the inner reef was investigated since the scope of work did not include these areas.

The reef complex found offshore Port Everglades is highly variable in terms of spatial distribution of its biological communities (Moyer et al. 2003) and does not conform to the classic reef zonation described for tropical and sub-tropical reef systems (Goreau 1959; Stoddart 1969; Loya 1972; Goldberg 1973). Numerous factors, such as seasonally cold ocean water, tidal inlet discharge, groundwater seepage, freshwater inputs and high variability of substratum complexity and composition have been proposed to explain why benthic communities of high latitude reefs off Florida differ from typical reefs of the western Atlantic region (Goldberg 1973). Although no longer a growing, or accreting reef system as it once was 5000 to 7000 years ago (Banks et al. 2007), the reef complex provides storm protection, habitat for invertebrates and fish species, and recreational uses that result in economic benefits to South Florida (Johns et al. 2001).

The biological communities of the Broward County reef complex likely to be impacted by the OEC improvements are dominated by algae, octocorals, sponges, and, to a lesser extent, hard corals, which form a thin veneer on the underlying mid-Holocene fossil-reef system (Goldberg 1973; Moyer et al. 2003; Gilliam et al. 2004; 2006; Banks et al. 2007; this study).

For the purposes of this report, general characterisitics and discussion of other authors' data will refer to second and third reefs, unless specific sites are referenced. The terms "Reef 2" and "Reef 3" refer specifically to the study sites surveyed and any data collected during this study in 2006. "Reef 2," also R2, is the study site located on the second reef and includes both north and south survey areas. There are three geographically distinct sites located on the third reef: (1) Reef 3 (R3), (2) Reef 3 Previously Impacted (R3-PI), and (3) Reef 3 Control (R3-C). Unless otherwise specified, "Reef 3" refers to the potential impact area for the proposed OEC improvement (the northemmost site on the third reef). The selection of study sites (described in Section 2.3.1) on the second and third reefs (Figure 1) were guided by USACE, based on proposed study design and study objectives as outlined above. Figure 2 shows a conceptual schematic of the OEC improvements under consideration.



Second Reef
(Middle Reef)
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Location of Study Sites
Benthic and Fish Community Assessment
at Port Everglades Harbor Entrance Channel
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DIAL CORDY
AND ASSOCIATES INC
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Figure 1

2.0 METHODS

2.1 Initial Benthic Habitat Mapping

Prior to the initiation of the on-site quantitative assessment, reef habitats were mapped/plotted using the latest data available including Laser Airborne Depth Sounder (LADS) information; Light Detection and Ranging (LIDAR) bathymetric information; acoustic bathymetric data; the most recent, high-resolution, color aerial photography; and geographic positioning system (GPS) integrated, towed, video survey data. The video surveys were conducted in the OEC and on the reef system in the proposed OEC improvement area in 2000, 2001, and 2002. These videos provided additional qualitative information of habitats within the study area.

Data were synthesized using ArcView Geographic Information System (GIS) software, which was subsequently used to generate habitat maps of the study sites. Maps were created in both two and three dimensions to assist in planning field operations and to characterize the reef habitats. The three-dimensional images created were also used to visualize the potential impacts of proposed OEC improvements on the existing reef structure.

2.2 Benthic Habitat Reconnaissance

Following desktop mapping efforts, field reconnaissance was conducted to identify habitat types of the reef system. The DC&A project team conducted multiple dives in each of the areas to be studied on the second and third reefs between February 14 and 22, 2006. Dive locations were selected from the information obtained during the desktop mapping effort. Visual observations and videographic data of the field reconnaissance provided information on the biological characteristics of the second and third reefs. Depth data were groundtruthed. Benthic cover type, the abundance of organisms, and the depths at which these occurred were used to define zonation patterns for the Study Design.

2.3 Quantitative Benthic Community Assessment

2.3.1 Study Design

Study sites were located on the second reef and third reefs. The hierarchical sampling scheme is shown in Table 1. Reef 2 was a single study site consisting of: Reef 2 North (R2 North) and R2 South, relative to the OEC (Figure 3). Three study sites were located on the third reef: Reef 3 (R3) (located within the footprint of the proposed extension of the OEC), R3 Previously Impacted (R3-PI) (located to the south of R3), and R3 Control (R3-C) (located to the south of R3 Previously Impacted) (Figure 3). The R3-PI study site is most likely the result of impacts caused by the dumping of material (likely dredge spoil) of size ranging from pebbles to boulders (personal communication, Richard Dodge, NOVA Southeastern University, Fort Lauderdale, FL). Each study site was subdivided into zones. There were two biological zones at R2, three at R3, three at R3-PI, and three at R3-C (Figure 3). In each zone, 12 to 16 replicate belt transects and fish assessments were conducted at two to four random points (Figures 4, 5, 6; Table 1).

Table 1. Sampling hierarchy, Port Everglades benthic assessment, March 2006

Sampling Hierarchy	**Port Everglades**										
Reefs	Second Reef		Third Reef								
Study Sites (n=4)	Reef 2 (R2)		Reef 3 (R3)			Previously Impacted (R3-PI)			Control (R3-C)		
Zones (n=11)	Zone 1	Zone 2	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Sampling Points (Random Points) (n=41)	4	4	4	4	4	3	3	3	4	4	4
Replicate Transects (n=159)	15	16	16	16	14	12	12	12	16	16	14

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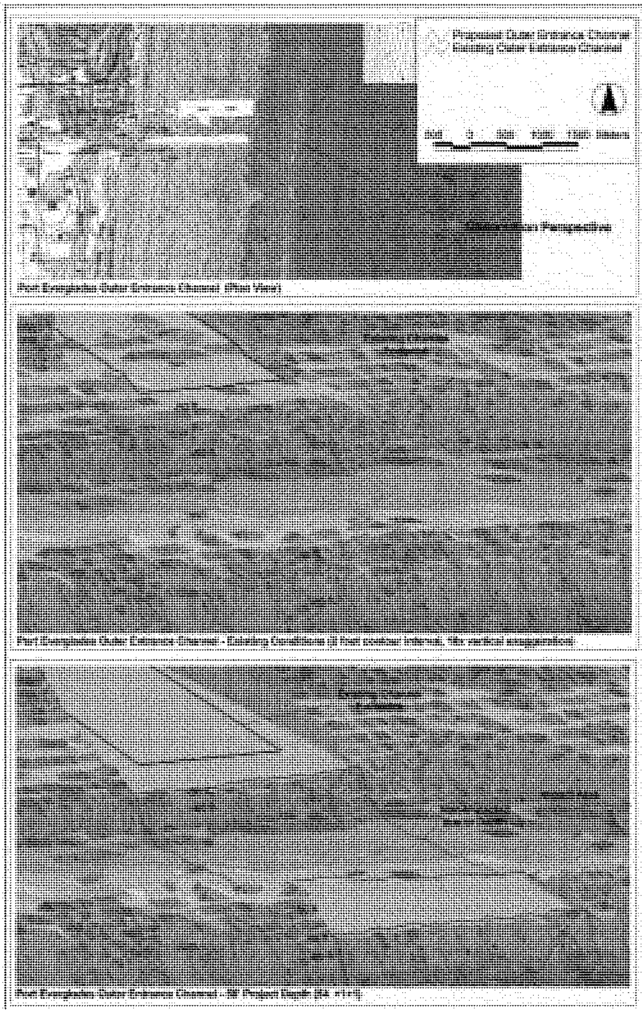

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Benthic and Fish Community Assessment at Port Everglades Harbor Entrance Channel

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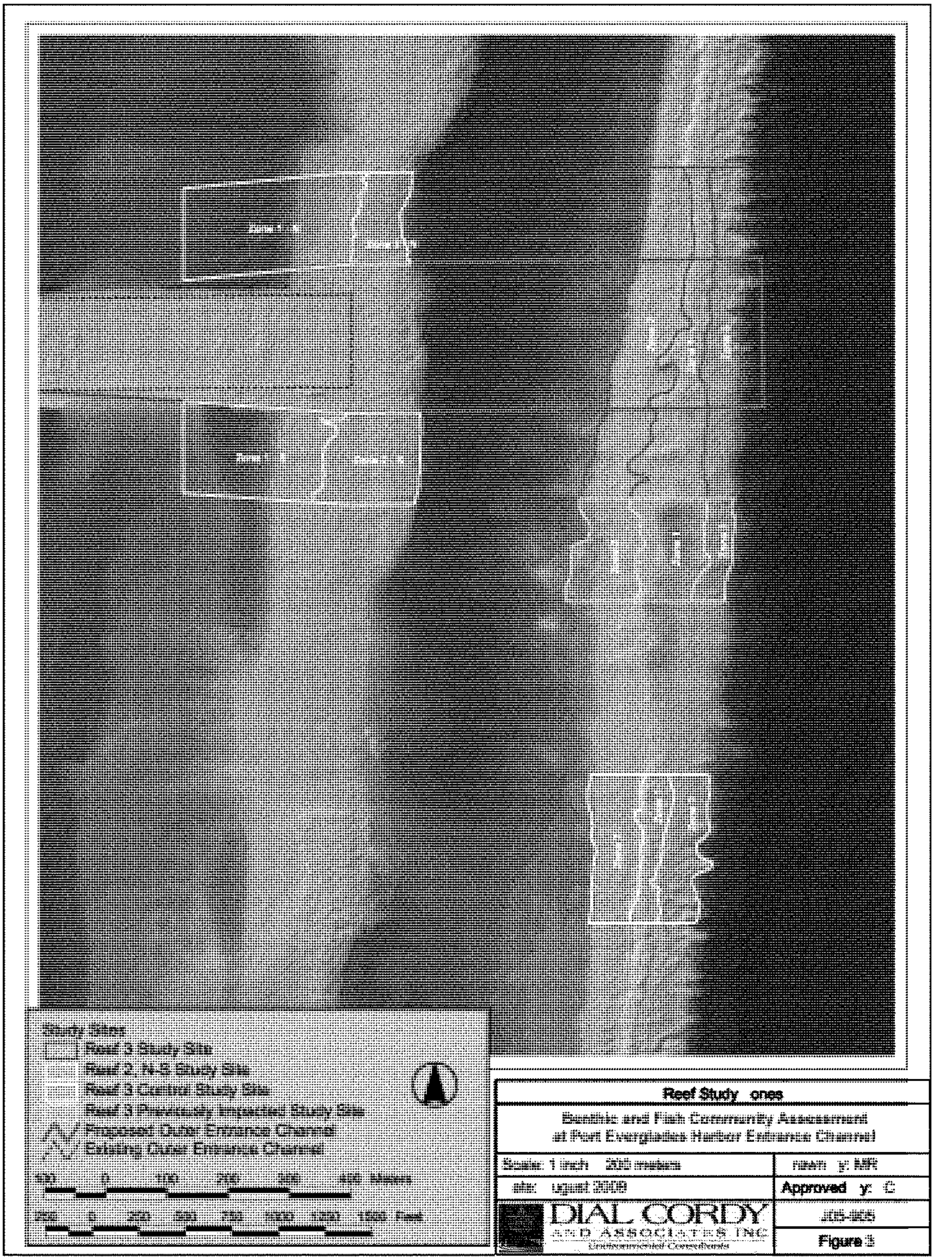
Study Sites
Reef 3 Study Site
Reef 2, N-S Study Site
Reef 3 Control Study Site
Reef 3 Previously Impacted Study Site
Proposed Outer Entrance Channel
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Environmental Consultants
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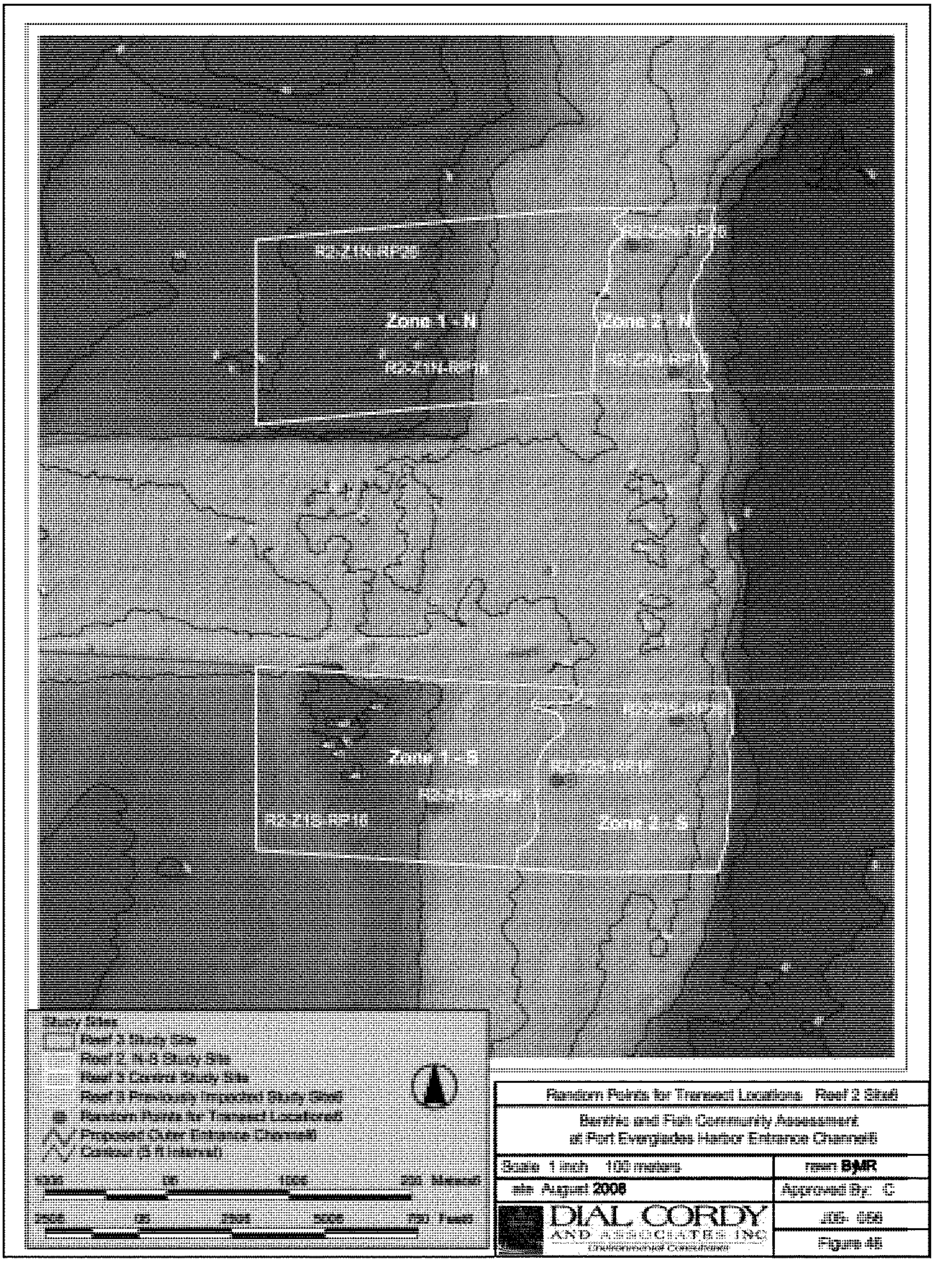
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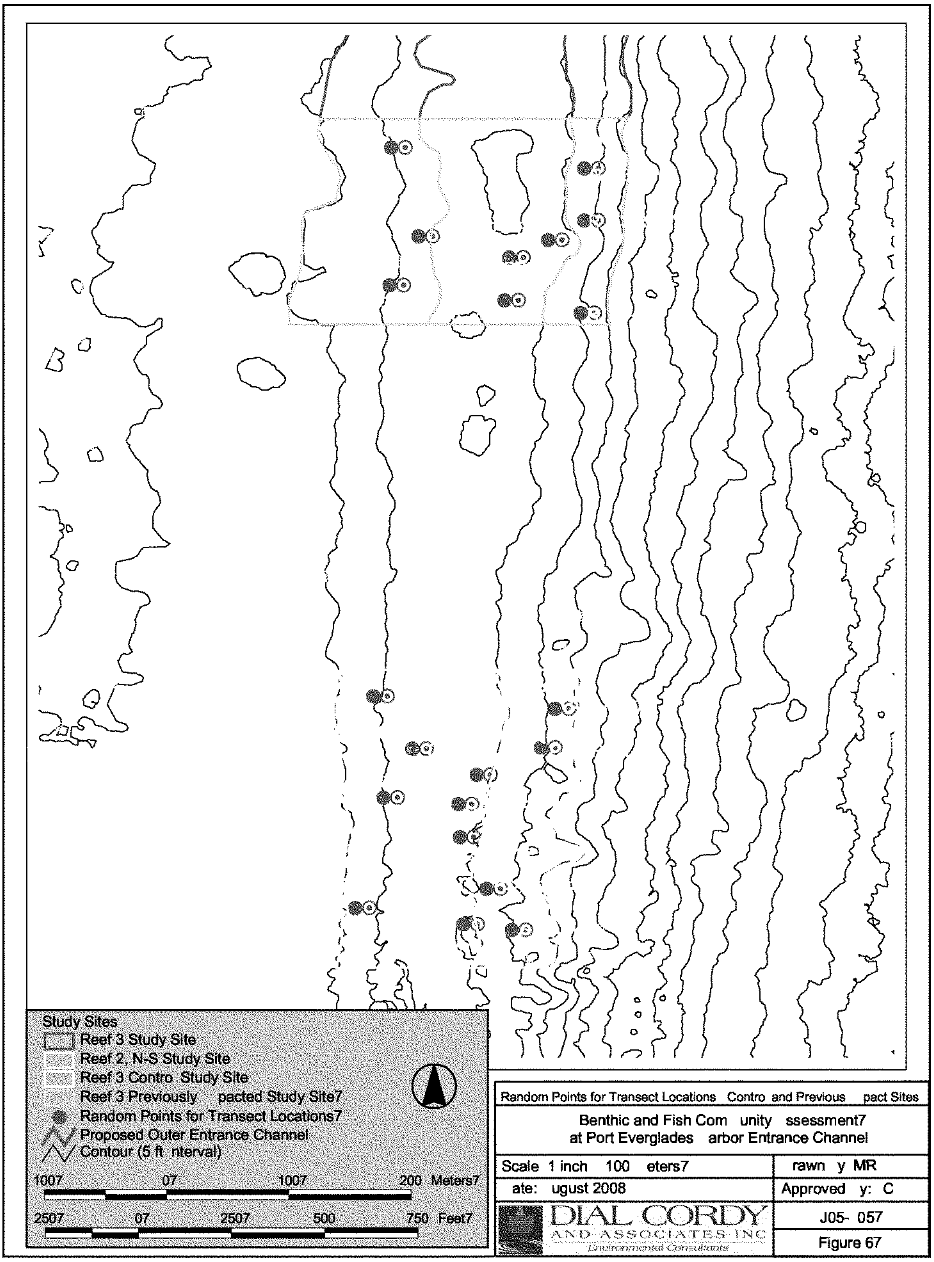
Study Sites
Benthic and Fish Community Assessment
at Port Everglades Harbor Entrance Channel
Scale 1 inch 100 meters
BJMR
August 2008
Approved By:
DIAL CORDY
AND ASSOCIATES INC


Random Points for Transect Locations Reef 3 Site
DIAL CORDY
AND ASSOCIATES INC
Figure 59


Study Sites
Reef 3 Study Site
Reef 2, N-S Study Site
Reef 3 Contro Study Site
Reef 3 Previously pacted Study Site7
Random Points for Transect Locations7
Proposed Outer Entrance Channel
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Random Points for Transect Locations Contro and Previous pact Sites
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Figure 67

The zonation of second and third reef study sites was established based on the abundance of sessile benthic organisms, water depth, and seafloor topography. The depth of the second reef study site (Reef 2) ranged from 15 m (45 ft) to 18 m (60 ft). Between 15 and 16 m octocorals were higher in abundance than sponges, while between 16 and 18 m sponges were more abundant than octocorals. The difference in abundance of benthic organisms indicated a biological zonation of the reef. Zone 1 was assigned to the shoreward 15 m to 16 m area, while Zone 2 was contained within the 16 m to 18 m depth range. The sizes of Reef 2 zones are shown in Table 2.

The depth of third reef study sites ranged from approximately 13 m (43 ft) to 19 m (60 ft). The shallowest part of the third reef formed a ridge running along the north-south axis of the tract. Between 13 and 15 m, the ridge supported a biological community with more octocorals, sponges, and scleractinians compared to either slope (i.e., between 14 and 19 m). The difference in abundance of benthic organisms indicated a biological zonation of the reef: Zone 1 was assigned to the ridge area contained between 13 and 15 m; Zone 2 was assigned to the shoreward slope of the ridge (16 to 19 m), and Zone 3 to the seaward slope (16 to 19 m). Sand and rubble bordered Zone 2 and a large progressively deeper hardbottom area bordered Zone 3. Reef 3 zone surface areas ranged from 2.8 to 4.6 ha (7.0 to 11.4 ac), Reef 3 Control zones ranged from 1.0 to 1.9 ha (2.4 to 4.7 ac), and Reef 3 Previously Impacted zones ranged from 0.8 to 1.8 ha (1.9 to 4.4 ac) (Table 2; Figures 4, 5, and 6). Further, The DC&A preliminary surveys of these sites revealed that live cover was discontinuous and interrupted by numerous patches of rubble and barren areas of hardbottom. This observation suggested that an adequate representation of each zone would necessitate a potentially large number of samples randomly scattered within each zone.

Table 2. Sizes of study sites surveyed off Port Everglades, Florida

Study Site	Zone	Area (ha)	Area (ac)
Reef 2	Zone 1	7.8	19.3
	Zone 2	3.5	8.7
Reef 3	Zone 1	3.3	8.2
	Zone 2	4.6	11.4
	Zone 3	2.8	7.0
Reef 3 – Control	Zone 1	1.0	2.4
	Zone 2	1.9	4.7
	Zone 3	1.6	3.9
Reef 3 – Previously Impacted	Zone 1	1.8	4.4
	Zone 2	1.7	4.2
	Zone 3	0.8	1.9

2.3.3 Sampling Design

The objectives of the quantitative benthic survey were to assess (1) the composition, density, size, coverage, and condition of benthic organisms (including scleractinians, octocorals, sponges, zoanthids, and macroalgae); and (2) the extent of bare substrate and unconsolidated substrate (sand, rubble). The methods used to assess the benthic organisms included both *in situ* visual assessments and videographic capture and point-count analysis conducted along belt transects (Aronson et al. 1994; Aronson and Precht 1995; Aronson and Swanson 1997; Murdoch and Aronson 1999; Aronson et al. 2005). Individual belt transects were 10 m long and 1 m wide for the visual assessments, and 10 m long and 0.4 m wide for video transects. The dimensions of individual belt transects were based on methods applied to coral reefs in Florida and the Caribbean (e.g., Loya 1976; Rogers et al. 1983; Liddell et al. 1984; Aronson and Precht 1995).

DC&A applied a random sampling design to each zone. DC&A established up to four random sampling stations in each zone from which four non-contiguous 10 m long replicate belt transect surveys were conducted. This was done to achieve maximum scatter within a zone and within sampling stations. A permanent marker (steel rod) was driven into the hardbottom to mark the location of each station. A weighted float was placed immediately above the station marker so that the Differential Global Positioning System (DGPS) geographic coordinates of the station could be acquired.

The randomization of sampling stations was done using the random point ("RP") generator V1.3 for ArcView GIS. At each sampling station, the origins of replicate transects were set at random distances between 1 and 5 m from the station marker. Random distances were selected from a table of random numbers (Rohlf and Sokal 1969). At each sampling station, the direction of the first transect was random (compass headings were selected randomly between 000 and 360 from a table of random numbers; Rohlf and Sokal [1969]). The second transect was perpendicular (90°) to the first transect, and so on. Transects were numbered in a clockwise manner. Figures 4, 5, and 6 illustrate the locations of the sampling stations. Table 3 lists the geographic coordinates of each sampling station per site and zone, the random heading of transect 1 at each sampling station and the random distances of transects from the sampling station.

Transect data at a given sampling station were pooled since the placement of transects around a common origin caused the transects to be dependent replicates. Since up to four 10 m long transects radiated from each sampling station, the total maximum area surveyed per station (or per sampling point) during *in situ* visual surveys was 40 m^2, and 16 m^2 for video surveys. A given reef zone totaled a maximum of 160 m^2 of in situ visual surveys and 64 m^2 of video surveys.

After the field portion of this study had been planned and conducted, it was brought to DC&A's attention that the boundaries of the Reef 3 Previously Impacted area selected in this study may have been underestimated. Specifically, the southernmost sampled areas within Reef 3 Zones 1 and 2 (R3-Z2-RP4 and R3-Z1-RP4) were possibly within the previously impacted area, as were the five northernmost points in the Reef 3 Control areas (i.e., R3C-Z1-RP1, R3C-Z2-RP1, R3C-Z2-RP2, R3C-Z3-RP1, and R3C-Z3-RP2) (personal communication Richard Dodge, NOVA Southeastern University, Ft. Lauderdale, Florida).

In total, from March 14 to March 26, 2006, the DC&A project team assessed the benthos at 41 random sampling stations (points) and 159 transects at Reef 2 and third reef sites (Figure 3; Table 4). Control data for Reef 2 were voluntarily not acquired since representatives of state and federal agencies, and regional experts agreed that DC&A could use pre-existing information on Reef 2 sites for comparisons (e.g., Gilliam et al. 2006).

Table 3. DGPS locations of random sampling stations (points), random bearing of each belt transect (T), and the distance used to locate the origin of belt transects away from station markers

Sampling Point	Longitude	Latitude	Bearing T1	Bearing T2	Bearing T3	Bearing T4	Distance from Pin (m)			
R3-C-Z1-RP1	80 05 05.11188	26 05 11.45211	237	327	57	147	2	3	5	4
R3-C-Z1-RP2	80 05 05.65536	26 05 10.67314	275	5	95	185	3	5	5	3
R3-C-Z1-RP3	80 05 05.60730	26 05 09.80128	290	20	110	200	1	1	1	3
R3-C-Z1-RP4	80 05 05.53766	26 05 07.47339	235	325	55	145	3	2	1	4
R3-C-Z2-RP1	80 05 08.14452	26 05 13.56109	45	135	225	315	5	2	2	4
R3-C-Z2-RP2	80 05 06.99285	26 05 12.15732	5	95	185	275	2	4	1	1
R3-C-Z2-RP3	80 05 07.85838	26 05 10.86538	211	301	31	121	3	2	1	1
R3-C-Z2-RP4	80 05 08.71474	26 05 07.92931	193	283	13	103	2	5	5	4
R3-C-Z3-RP1	80 05 02.79512	26 05 13.19042	53	143	233	323	4	3	2	4
R3-C-Z3-RP2	80 05 03.20892	26 05 12.16303	314	44	134	224	5	5	4	4
R3-C-Z3-RP3	80 05 04.85031	26 05 08.41982	217	307	37	127	5	3	2	2
R3-C-Z3-RP4	80 05 04.11302	26 05 07.32570	116	206	296	26	1	5	3	3
R2-Z1N-RP1	80 05 28.95607	26 05 42.65196	331	61	151	241	3	5	5	3
R2-Z1N-RP2	80 05 31.12151	26 05 44.89400	273	3	93	183	1	1	1	3
R2-Z1S-RP1	80 05 30.45397	26 05 30.48934	233	323	53	143	3	3	2	1
R2-Z1S-RP2	80 05 27.73397	26 05 30.47221	43	133	223	313	1	4	4	3
R2-Z2N-RP1	80 05 20.55932	26 05 41.98495	322	52	142	232	5	1	5	1
R2-Z2N-RP2	80 05 21.78337	26 05 45.38975	168	258	348	78	4	1	3	4
R2-Z2S-RP1	80 05 24.12000	26 05 31.17242	56	146	236	326	2	3	5	2
R2-Z2S-RP2	80 05 20.59806	26 05 32.73483	28	118	208	298	1	2	3	2
R3-Z1-RP1	80 05 02.43165	26 05 45.78223	356	86	176	266	4	4	5	2
R3-Z1-RP2	80 05 03.13963	26 05 39.37883	117	207	297	27	1	2	5	1
R3-Z1-RP3	80 05 02.69537	26 05 34.45372	0	90	180	270	2	3	3	2
R3-Z1-RP4	80 05 03.61424	26 05 31.95383	57	147	237	327	4	4	2	1
R3-Z2-RP1	80 05 04.19735	26 05 45.81325	359	89	179	269	3	4	1	2
R3-Z2-RP2	80 05 06.45387	26 05 39.15226	243	333	63	153	1	1	4	1
R3-Z2-RP3	80 05 06.73468	26 05 34.07328	306	36	126	216	5	3	3	3
R3-Z2-RP4	80 05 06.44776	26 05 31.47661	335	65	155	245	2	5	5	4
R3-Z3-RP1	80 05 00.26073	26 05 44.26303	125	215	305	35	2	1	3	3
R3-Z3-RP2	80 05 00.60936	26 05 38.93689	107	197	287	17	2	5	1	5
R3-Z3-RP3	80 05 01.35739	26 05 35.84169	324	54	144	234	3	5	5	1
R3-Z3-RP4	80 05 01.38874	26 05 34.63360	38	128	218	308	1	3	1	2
R3-PI-Z1-RP1	80 05 02.89546	26 05 25.66022	87	177	267	357	2	5	4	4
R3-PI-Z1-RP2	80 05 04.03971	26 05 25.20199	243	333	63	153	1	4	2	5
R3-PI-Z1-RP3	80 05 04.19107	26 05 24.07390	147	237	327	57	3	3	2	3
R3-PI-Z2-RP1	80 05 07.50468	26 05 28.14566	125	215	305	35	1	3	4	5
R3-PI-Z2-RP2	80 05 06.71141	26 05 25.78347	147	237	327	57	1	5	3	2
R3-PI-Z2-RP3	80 05 07.57696	26 05 24.49153	58	148	238	328	2	5	5	3
R3-PI-Z3-RP1	80 05 01.81672	26 05 27.56485	73	163	253	343	4	5	3	5
R3-PI-Z3-RP2	80 05 01.83848	26 05 26.17842	36	126	216	306	1	2	4	3
R3-PI-Z3-RP3	80 05 01.95640	26 05 23.71307	280	10	100	190	2	5	5	4

Table 4. Reef site-zone, sampling point, number of samples and corresponding sampled area of visual and videographic transects conducted off Port Everglades in March 2006 [R=Reef; Z=Zone; P=Previously Impacted; C = Control; N=North; S=South; RP=Random Point]

Reef Site-Zone	Sampling Point	Visual Transects N	Visual Transects Area (m^2)	Video Transects N	Video Transects Area (m^2)
R2-Z1	N-RP1	4	40	4	16
	N-RP2		40		16
	S-RP1		40		16
	S-RP2		20		12
R2-Z2	N-RP1	4	40	4	16
	N-RP2		40		16
	S-RP1		40		16
	S-RP2		40		16
R3-Z1	RP1	4	40	4	16
	RP2		30		16
	RP3		40		16
	RP4		40		16
R3-Z2	RP1	4	40	4	16
	RP2		30		16
	RP3		40		16
	RP4		40		16
R3-Z3	RP1	4	40	4	16
	RP2		40		16
	RP3		30		16
	RP4		20		8
R3-PI-Z1	RP1	3	40	3	16
	RP2		40		16
	RP3		40		16
R3-PI-Z2	RP1	3	40	3	16
	RP2		40		16
	RP3		40		16
R3-PI-Z3	RP1	3	40	3	16
	RP2		40		16
	RP3		40		16
R3-C-Z1	RP1	4	40	4	16
	RP2		40		16
	RP3		40		16
	RP4		40		16
R3-C-Z2	RP1	4	20	4	16
	RP2		40		16
	RP3		40		16
	RP4		40		16
R3-C-Z3	RP1	4	40	4	16
	RP2		40		16
	RP3		20		16
	RP4		40		8

2.3.3.1 Visual Assessment of Benthos

The DC&A project team conducted visual assessments of the benthos 50 cm on either side of a 10-m transect tape loosely draped on the seafloor. Visual assessments were typically done in sets of four transects [four transects per sampling station (or per random point (RP)]. A work sheet printed on underwater paper was used to record data on scleractinians and hydrocorals (species richness, maximum diameter per colony, number of colonies per species, condition of each colony), octocorals (list of genera, maximum height per colony, number of colonies per genus), sponges (list of genera, number of *Xestospongia muta* colonies, maximum height per *X. muta* colony), zoanthids (number of colonies, maximum diameter per colony), algae (list of genera), substrate type, sediment depth, and the maximum height of the substrate relief. The size classes of scleractinians were pre-assigned as follows: Class I = 0-3 cm; Class II = 4-10 cm; Class III = 11-25 cm; Class IV = 26-50 cm. The size classes of octocorals were pre-assigned as well: Class I = 0-10 cm; Class II = 11-25 cm; Class III = 26-50 cm; Class IV = > 50 cm. The data collected during the visual assessments are included in Appendix A.

Quality Assurance/Quality Control (QA/QC) for the visual assessment method was done in the field before the belt transect data collection. The goal of the QA/QC was to achieve the highest possible agreement between observers (less than 10% error). A total of three marine scientists participated in the visual assessment and the QA/QC process at the onset of the fieldwork. Each of the three observers independently recorded the identification and size of the same scleractinians and octocorals along the same transects. Individual specimens were labeled by assigning a sequential number, which was written on an underwater etch-a-sketch pad. Photographic voucher samples were taken of specimens, including the specimen number. These photographs were later used to address discrepancies between observers. Discrepancies were discussed and consensus was reached. This was carried on at three separate transects until divers were in agreement 90% of the time. It is likely that the high level of agreement was partly due to the low diversity in this general area.

Scleractinian species diversity based on data collected in visual belt transects was calculated using the Shannon-Wiener diversity index (*H'*):

$$H' = -\sum_{i=1}^{k} p_i \log p_i$$

where k is the number of species present and p_i the proportion (n_i/N) of the ith species.

A model II ANOVA [single factor analysis of variance for a random effects model (Zar 1984)] was used to compare scleractinian species richness (*S*) and scleractinian colony density data between zones within and among reef sites. Differences between zones were further analyzed using the Tukey multiple means test (Zar 1984). To allow the valid application of parametric analyses of variance, data were transformed to make them normal, homoscedastic, and additive (Zar 1984; Aronson et al. 1994). Species richness and colony density values were logarithmically transformed (Zar 1984; Aronson et al. 1994). Species diversity data were not transformed because *H'* values were normally distributed (D'Agostino's test of departure from normality; Zar 1984). Differences between Shannon-Wiener diversity indices were tested using Hutcheson's (1970) t-test.

2.3.3.2 Videographic Assessment of Benthos

Given logistical constraints (including limited bottom time due to ship traffic, depth, visibility, and sea conditions), videography was preferred over photography as a method to acquire permanent and representative quantitative samples of benthos along belt transects. The video camera was placed in an underwater housing and fitted with a wide-angle lens. Videographic belt transects were recorded along 10 m-long measuring tapes draped over the hardbottom. At the beginning of each video transect, two panoramic landscape videos above the transect reference point were taken. First, the video camera was held at 30 degrees to the horizon and 1 m above the seafloor while the diver videotaped in a full circle around the transect reference point for 20 to 25 seconds. Second, the video camera was held 2 m above the bottom, parallel to the seafloor and recorded a full circle around the transect reference point for 20 to 25 seconds. A 40 cm swath of hardbottom on the left side of the 10 m transect from a height of 40 cm was videotaped using a digital video camera held perpendicular to the seafloor. The diver handling the video camera swam slowly (30 seconds per meter) along the entire length of each transect (including permanent reference marker and transect origin) to ensure that clear stop-action images for analysis were obtained. The camera was maintained at a constant height above the bottom using a pre-measured aluminum bar that projected forward from the camera. At the end of the bar was a depth gauge and scaling bar.

The stop-action images of the hardbottom measured 40 cm by 27 cm, or 1080 cm^2. The proximity of the camera lens to the hardbottom surface and the 4 mm resolution of the images allow the identification of hard corals down to a colony size of approximately 5 cm. Larger video frames would not allow this level of precision. The video transects were used to report on hard coral percent cover and species diversity; and percent cover of gorgonians, sponges, zoanthids, and macroalgae all of which were identified to the lowest practical taxonomic level.

Each video transect yielded approximately 25 stop-action images that were non-overlapping. Each stop-action image was processed via computer software (ULEAD). Hard coral, octocoral, hydrocoral (*Millepora alcicornis*), macroalgae, turf algae, sediment, and rubble percent cover, as well as species diversity for hard corals (expressed as species richness, *S*, and as the Shannon-Wiener Index, *H'*), were determined from video images. These parameters were estimated using the point-count software CPCe®. The adequate number of dots per video image and per transect was defined by examining changes in mean and standard deviation of percent cover and *H'* as a function of the number of dots per image and per transect. The adequate number of dots was 30 per image, and approximately 750 per transect, depending on the actual number of still images per transect. The data extracted from the videographic analysis are included in Appendix B.

QA/QC for the video method consisted of observers analyzing the same video transects and completing benthic component identification. Results were compared and observers were in agreement on 90% of point identifications along transects. The most discrepancies were found identifying small corals. The general category "coral" was used to avoid misidentification of scleractinian corals smaller than 3 cm in diameter.

Transects were treated as replicates within a zone, yielding an estimate of coral cover as well as other living and non-living (i.e., sand) benthic categories. Percent coverage was calculated for each transect from the resulting set of random points (RPs) generated using the CPCe® software. Data were collected on the point-counts of each coral species as well as various functional groups including octocorals, sponges, macroalgae, turf algae (>3 mm), and sand and rubble, (which were combined for statistical analysis as the non-living portion of benthic cover). Graphs were produced to allow the comparison of average percent cover of major substrate types, including coral species, octocoral, sponge, macroalgae, and turf algae functional types, between and within sites.

The benthic percent cover data were statistically analyzed for significant differences among and between sites. The following benthic cover data categories were analyzed: scleractinian coral, *Millepora alcicornis*, octocorals, macroalgae, turf algae, sponge, sediment, and rubble. Diversity as measured by the Shannon-Weiner Index (*H'*) was calculated for scleractinian corals.

All statistical tests were completed using SAS 9.1. First, the data were tested for normality. Since the data were not normal, they were transformed by the log(x+1) function and retested for normality using the Wilks-Shapiro test. After log(x+1) transformation the data were generally normally distributed. Data were analyzed using parametric and non-parametric methods. Data were first analyzed using the ANOVA Procedure (SAS). It was determined that the four transects associated with a given random point were generally similar, so these transects were pooled by random point for further analyses. ANOVAs were run which analyzed zones within sites and zones across sites for each taxonomic category. Zones were not pooled within sites because there were significant differences between zones within sites. Thus, models were run with zones nested within sites. In order to identify specifically which zones or sites were dissimilar from each other, Tukey multiple means tests were run simultaneously with the ANOVAs (Means/Tukey option in the ANOVA Procedure (SAS)). Pearson correlation coefficients were computed using the Corr Procedure (SAS). The coefficients were computed by site, by zone, and for each site/zone combination.

2.4 Fish Census

Fish censuses were conducted in conjunction with the quantitative benthic community assessment. A single trained fish biologist conducted all fish censuses. Two methods were employed: a point-count method following Bohnsack and Bannerot (1986) and belt transect method. Since many of the sampling stations were relatively close to one another, fish surveys were conducted at two of the four possible sampling stations per reef zone. This was done primarily to prevent pseudoreplication (Hurlbert 1984) especially for some of the more mobile fish species (e.g., trigger fishes, spade fish, snappers). Care was taken during each fish survey to note any potential reoccurrences of such highly mobile fauna. The locations of fish censuses were selected randomly using a table of random numbers (Rohlf and Sokal 1969). Fish identifications were made to the lowest taxon possible and total fish length was recorded. Humann (2005) was consulted to confirm fish identifications. Fish data were recorded on underwater paper and transferred to spreadsheets from which descriptive statistics were calculated.

Once a station marker was installed and the four transect tapes had been draped over the reef, point-count surveys were conducted at a 7.5 m distance from the end of the belt transects. Sixteen independent random point counts were conducted within each zone. A point count was conducted within an imaginary cylinder that had a 7.5 m radius and a height spanning from the seafloor to the sea surface. All species present within the cylinder were counted during the first five minutes. Thereafter the size classes and numbers of individuals of each species were recorded. Fish sizes were estimated using a 30 cm ruler attached to the end of a 1 m rod.

In addition to point counts, belt transect counts were conducted to capture small and cryptic species. At two sampling stations per reef zone, transect counts were conducted along each of the belt transects used for the benthic assessments. The data recorded included fish species, the abundances and sizes of fish found within a 1 m distance of the belt transect. A maximum of 40 m^2 were surveyed in this manner at each sampling station.

3.0 RESULTS

3.1 Benthic Survey – Visual Assessment

3.1.1 Sampling Site Characteristics

A large percentage of the seafloor cover (19%-57%) of the study sites consisted of bare substrate (consolidated and unconsolidated substrates). Hard substrate was typically interspersed by small sand pockets, shell hash, and areas of rubble (Table 5). There were, however, large sand flats at R2-Z2. The overall thickness of sand/shell hash ranged from 2 cm to more than 30 cm. Artificial substrates, though low in cover, were found within all belt transects, except R3-C-Z3. Most artificial substrates were small and had low relief. They included metallic cables, fishing line and weights, wood, rope, iron angle, and other metallic objects (Table 5). The artificial substrate with the greatest amount of vertical relief was cylindrical (27 cm high, 55 cm diameter) and was found within a belt transect at R2-Z1. Rocks, boulders, and sponges (in particular, *X. muta*) generated the greatest amount of relief among study sites. Maximum vertical relief varied from 0.45 to 1.50 m (Table 5).

Following are general descriptions of each of the sites by reef site, zone, and sampling station (i.e., random point, or "RP"):

<u>Reef 2</u>

- Zone 1, RP1: Hardbottom with sand/shell hash
- Zone 1, RP2: Desolate area, rubble, and some broken carbonate substrate
- Zone 1, RP3: Hardbottom, sand channel, and abundant sponges
- Zone 1, RP4: Hardbottom, abundant sand, rubble, human-made debris (wood, aluminum can), and high sedimentation
- Zone 2, RP1: Coarse sand, rubble, scattered rocks, and some bunched up cables
- Zone 2, RP2: Transects 1 and 2 contained a large sand flat (fine sand) abutting hardbottom. The substrate underlying transect 3 was characterized by hardbottom and small sand pockets
- Zone 2, RP3: Patchy hardbottoms interspaced by sand flats (fine sand and shell hash)
- Zone 2, RP4: Flat area of hardbottom and rubble.

<u>Reef 3</u>

- Zone 1, RP1: Hardbottom, little relief except for *X. muta*, fishing line encrusted by *Millepora alicornis*
- Zone 1, RP2: Hardbottom, rubble, rocks, small pockets of coarse sand
- Zone 1, RP3: Hardbottom, boulders, gravel
- Zone 1, RP4: Hardbottom with rubble and rocks, pockets of coarse sand, fine sediment covering the seafloor
- Zone 2, RP1: Hardbottom, rubble, rocks, and small coarse sand pockets
- Zone 2, RP2: Rubble and rocks
- Zone 2, RP3: Hardbottom, rubble, rocks, coarse sand, and artificial substrate (metal); RP4: Hardbottom, rocks, rubble, large rocks, coarse sand, and heavy sedimentation.

- Zone 3, RP1: Hardbottom, rubble, rocks, and fine sand covering hard substrate
- Zone 3, RP2: Hardbottom, and some artificial substrate (fishing line)
- Zone 3, RP3: Hardbottom, rubble, rocks, and some artificial substrate (metallic cable)
- Zone 3, RP4: Hardbottom and boulders

Reef 3, Previously Impacted

- Zone 1, RP1: Abundant turf, hardbottom, rocks, boulders, abundant rubble, coarse sand, artificial substrate (rope), and rubble found inside *X. muta*
- Zone 1, RP2: Abundant turf, hardbottom, rocks, rubble, coarse sand, and high sedimentation
- Zone 1, RP3: Hardbottom with boulders, rocks, rubble, and small pockets of coarse sand
- Zone 2, RP1: Hardbottom, rubble, scattered rocks, coarse sand
- Zone 2, RP2: Hardbottom, scattered rocks, rubble, coarse sand, and high sedimentation
- Zone 2, RP3: Hardbottom, scattered rocks, rubble, coarse sand, and artificial substrate (cable, brick, fishing line)
- Zone 3, RP1: Hardbottom, rocks, rubble, small pockets of coarse sand, abundant burrowing activity in rubble
- Zone 3, RP2: Hardbottom, rubble, rocks, coarse sand, burrowing activity, and artificial substrate (cable, fishing line)
- Zone 3, RP3: Hardbottom, coarse sand, boulders, rocks, and rubble

Reef 3, Control

- Zone 1, RP1: Hardbottom
- Zone 1, RP2: Hardbottom with sand patch
- Zone 1, RP3: Hardbottom with some sand, gravel, cobbles, and sand flat
- Zone 1, RP4: Scattered rocks with abundant turf cover, hardbottom, sand, and artificial substrate (fishing gear)
- Zone 2, RP1: Hardbottom with rubble and sand, high sedimentation, a cable runs through the site, abundant sponges
- Zone 2, RP2: Hardbottom, rock, rubble, loose rocks, coarse sand, and juvenile corals growing on loose rocks
- Zone 2, RP3: Hardbottom, rubble, and sand
- Zone 2, RP4: Coarse sand and hardbottom
- Zone 3, RP1: Hardbottom with rubble
- Zone 3, RP2: Hardbottom with rubble, coarse sand, high sedimentation
- Zone 3, RP3: Hardbottom with rubble, sand pockets, coarse sand
- Zone 3, RP4: Hardbottom with sand, and high sedimentation

Table 5. General substrate characteristics by reef site and zone off Port Everglades based on visual belt transects conducted in March 2006. Presence of a substrate is indicated by an "x." [R =Reef; Z = Zone; PI = Previously Impacted; C = Control]

Reef Site	**R2**		**R3**			**R3-PI**			**R3-C**		
Zone	Z1	Z2	Z1	Z2	Z3	Z1	Z2	Z3	Z1	Z2	Z3
Bare Substrate Cover (%)	30	57	19	29	32	35	49	41	28	32	33
Hardbottom	x	x	x	x	x	x	x	x	x	x	x
Boulders			x	x	x	x		x			
Rocks		x	x	x	x	x	x	x	x	x	
Rubble	x	x	x	x	x	x	x	x		x	x
Gravel			x						x		
Shell Hash	x	x									
Sand	x	x	x	x	x	x	x	x	x	x	x
Sand/Shell Hash Thickness (cm)	5-15	5-30+	2	2-4	4	4	2	2-7	<2-10	2-20	5-10
Artificial substrate	x	x	x	x	x	x	x	x	X	x	
Sedimentation	x		x	x		x	x			x	X
Maximum relief (m)	1.0	0.70	0.70	0.90	1.21	0.80	0.90	0.75	1.0	1.5	0.45
Depth Range (m)	15-16	16-18	15-16	17-19	17-19	15-18	16-18	17	14-16	16-18	16-18

3.1.2 Sample Size Adequacy

The emphasis of the visual assessment was to quantify the scleractinian and octocoral populations. The scleractinian species richness and species diversity was assessed using colony counts, colony density, colony size, and colony condition. The number of octocoral genera, density of octocorals, and size of octocoral colonies was also assessed.

As mentioned above, transects were pooled at each random sampling point. For example, at the first random point RP1 of site R2-Z1, four transects were acquired, each 10 m long and 1 m wide, which pooled yielded a single belt transect that was 40 m long and 1 m wide (equivalent to a belt transect area of 40 m^2).

Previous studies of the second and third reefs in Broward County, Florida used 30 m^2 as an adequate sample size to document scleractinian species richness, density, and percent cover (Gilliam et al. 2004). Sample adequacy in Gilliam et al. (2004) was verified using scleractinian species-area rarefaction curves. The optimal sampling area was attained when the cumulative number of scleractinian species plateaued. By pooling transects at each random sampling point in this study, we acquired 41 sets of transects individually ranging from 20 to 40 m^2 per sample. Samples that were less than 30 m^2 were excluded from the analysis of species richness and density based on visual assessments. Zones R2-Z1, R3-Z3, R3-C-Z2, and R3-C-Z3 each contained one belt transect equivalent to 20 m^2. The subtraction of these samples resulted in a sample size of 3 (n=3) at each of these zones. Sample size adequacy was based upon scleractinian species richness curves because these organisms were the focus of concern for the project.

The adequacy of sample sizes used to estimate coral percent cover based on videographic belt transects was determined by plotting percent cover-area rarefaction curves; adequate sample size was attained when the cumulative sampling area yielded representative cover estimates (Figure 7). In most cases (eight of 11 zones), 16 m^2 was an adequate sample size. At R2-Z2, R3-Z3, and R3-PI-Z3, 20 m^2 was an adequate sample size. In a few cases, substrate heterogeneity (particularly at R2-Z2) may explain the need for a greater sample size.

3.1.3 Benthic Organisms

3.1.3.1 Hard Corals-Scleractinians

Species Richness – The number of scleractinian species (species richness, *S*) encountered by reef site and zone within the visual belt transects varied from 9 to 18 (Figure 8). Reef 2 yielded the lowest species richness ($S_{R2\text{-}Z1}$ = 11; $S_{R2\text{-}Z2}$ = 9) (Table 6; Figure 8). The highest scleractinian species richness was recorded at R3 and R3-PI ($S_{R3\text{-}Z3}$ = 16; $S_{R3\text{-}PI\text{-}Z3}$ = 18). The most common scleractinians in decreasing order of abundance were *Siderastrea siderea*, *Stephanocoenia intersepta*, *Porites astreoides*, *Montrastraea cavernosa*, and *S. radians* (Table 7).

Table 6. Number of scleractinian colonies, species richness, and density of scleractinian colonies by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. [*SD* = standard deviation; *N* = number of belt transects; R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Reef Site-Zone	Colonies	Species	Mean Density (colonies/m^2)	*SD*	*N*
R2-Z1	60	11	0.43	0.70	14
R2-Z2	84	9	0.53	0.53	16
R3-Z1	329	13	2.19	0.72	15
R3-Z2	214	12	1.43	0.54	15
R3-Z3	261	16	2.01	1.05	13
R3-PI-Z1	284	14	2.37	0.82	12
R3-PI-Z2	173	15	1.44	0.50	12
R3-PI-Z3	213	18	1.78	0.80	12
R3-C-Z1	204	15	1.28	0.66	16
R3-C-Z2	122	13	0.92	0.43	14
R3-C-Z3	199	14	1.42	1.01	14

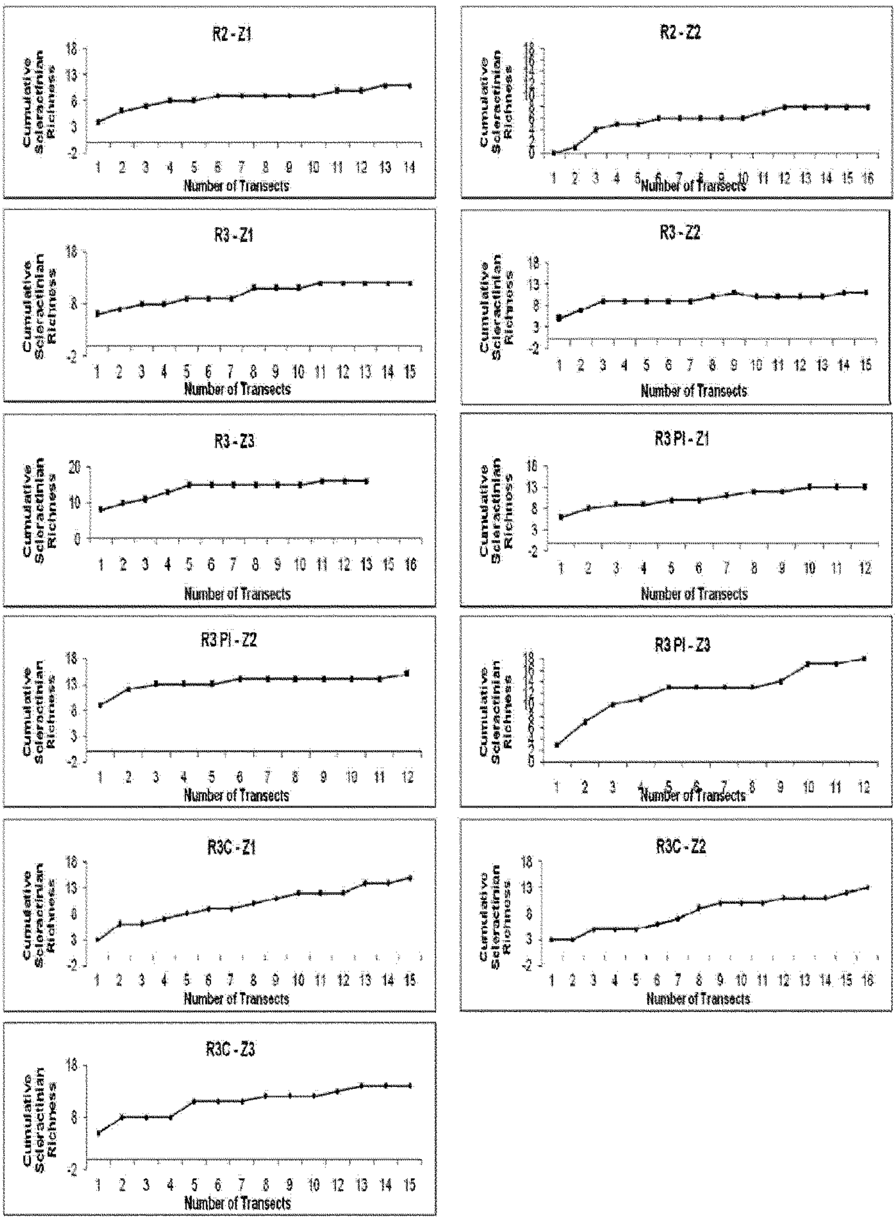

Figure 7. Scleractinian coral species richness rarefaction curves based on visual transects acquired at Reef 2 and third reef sampling sites off Port Everglades, Florida in March 2006

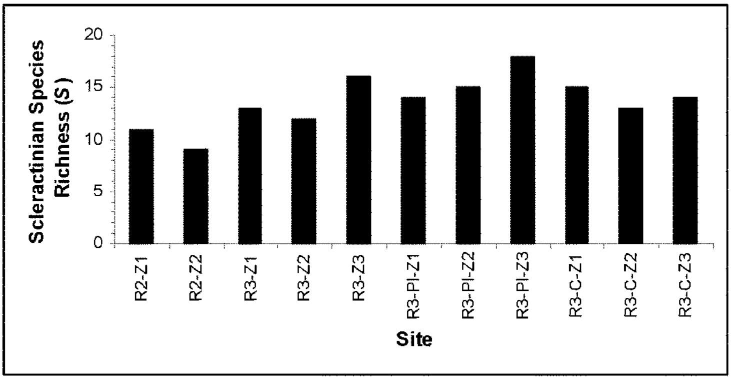

Figure 8. Scleractinian species richness (S) by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Table 7. Number of scleractinian colonies by species, reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. Species are listed in alphabetic order. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Species	R2		R3			R3-PI			R3-C		
	Z1	Z2	Z1	Z2	Z3	Z1	Z2	Z3	Z1	Z2	Z3
Agaricia agaricites	1		4	1	8	1	1	2	2	5	4
Agaricia fragilis							1				
Agaricia humilis								1			
Agaricia lamarcki					1						
Colpophyllia natans		1						1	1		
Dichocoenia stokesii	1		4	8	2	2	6	6	5	1	5
Diploria labyrinthiformis						1		1			
Diploria strigosa	2		2		1	1		2	1		
Eusmilia fastigiata		1						1		1	2
Favia fragum								1			
Leptoseris cucullata											1
Madracis decactis	1	4	5	9	11	8	11	7	8	2	5
Manicina areolata							1	1			
Meandrina meandrites	3	2	7	6	7	2	3	3	2	1	2
Montastraea annularis	5	7	2		5	4	5	8	2	4	7
Montastraea cavernosa	7	11	54	23	28	21	24	25	39	17	28
Mycetophyllia aliciae				2							
Mycetophyllia ferox					1	1			1		
Porites astreoides	3	8	83	20	49	61	16	33	57	20	32
Porites porites			5	1	4	8	2		6	10	12
Scolymia spp.			1	1	1		1				
Siderastrea siderea	21	19	75	57	66	106	38	57	38	37	39
Siderastrea radians	6	5	29	18	13	15	15	17	10	5	8
Solenastrea bournoni					1		1		2	3	2
Stephanocoenia intersepta	10	26	58	68	63	51	48	47	30	26	52
Total	60	84	329	214	261	282	173	213	204	132	199

Mean coral species richness based on visual assessments was not different between Reef 2 zones ($t_{0.05(2),4}$ = -0.314; $P > 0.50$). Further, mean coral species richness based on visual assessments was not different between zones within all third reef sites (R3, R3-PI, and R3-C) ($F = 1.91$; $P = 0.10$). Results of a one-way analysis of variance (ANOVA) testing whether differences of species richness existed between zones at all third reef sites (R3, R3-PI, and R3-C) were as follows:

Source of Variation	**SS**	**DF**	**MS**	**F**	**P-value**	**F crit**
Between Groups	0.082214	8	0.010277	1.909531	0.105377	2.355081
Within Groups	0.129163	24	0.005382			
Total	0.211377	32				

Species Diversity – Scleractinian species diversity expressed as *H'* and based on the number of coral colonies per species collected in visual belt transects ranged from 0.77 to 0.91 (Table 8). The comparison of between-zone species diversity using Hutcheson's modified t-test (Hutcheson 1970) showed that there were significant differences between third reef sampling sites (R3, R3-PI, and R3-C) (Table 9). Reef 3-Previously Impacted-Zone 1 (R3-PI-Z1) was the least diverse, while R3-C-Z3 was the most diverse zone. (Table 8). Reef 3-Previously Impacted-Zone 1 (R3-PI-Z1) was significantly less diverse than R3-PI-Z2 and R3-PI-Z3, all zones in R3-C, and R3-Z3 (Table 9). The most diverse zones were R3-C-Z3 and R3-PI-Z3; they were significantly more diverse than R3-Z1, R3-Z2, and R3-PI-Z1 (Table 8). While species richness at Reef 2 zones was significantly lower compared to all other sampling sites, species diversity (*H'*) was not. In fact, species diversity based on the number of colonies was not significantly different between Reef 2 and any other site ($P > 0.05$).

Table 8. Scleractinian species diversity (*H'*) based on the abundance of coral colonies in visual belt transects off Port Everglades in March 2006. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Site	R2		R3			R3-PI			R3-C		
	Z1	Z2	Z1	Z2	Z3	Z1	Z2	Z3	Z1	Z2	Z3
H'	0.86	0.83	0.82	0.81	0.87	0.77	0.89	0.90	0.87	0.88	0.91

Table 9. Significant differences in scleractinian species diversity (*H'*) resulting from Hutcheson's modified t-test (Hutcheson 1970) as applied to coral colony counts in visual belt transects off Port Everglades in March 2006. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Significant Differences	**Test Results; Level of Significance**
R3-Z1 < R3-PI-Z3	$\lvert t_{0.05(2), 410.76} \rvert = 2.06$; $P < 0.05$
R3-Z1 < R3-C-Z3	$\lvert t_{0.05(2), 404.19} \rvert = 2.42$; $P < 0.05$
R3-Z2 < R3-PI-Z2	$\lvert t_{0.05(2), 366.77} \rvert = 2.16$; $P < 0.05$
R3-Z2 < R3-PI-Z3	$\lvert t_{0.05(2), 424.02} \rvert = 2.26$; $P < 0.05$
R3-Z2 < R3-C-Z3	$\lvert t_{0.05(2), 411.27} \rvert = 2.57$; $P < 0.05$
R3-PI-Z1 < R3-Z3	$\lvert t_{0.05(2), 542.59} \rvert = 2.92$; $P < 0.05$
R3-PI-Z1 < R3-PI-Z2	$\lvert t_{0.05(2), 392.94} \rvert = 3.18$; $P < 0.05$
R3-PI-Z1 < R3-PI-Z3	$\lvert t_{0.05(2), 419.36} \rvert = 3.30$; $P < 0.05$
R3-PI-Z1 < R3-C-Z1	$\lvert t_{0.05(2), 424.19} \rvert = 2.56$; $P < 0.05$
R3-PI-Z1 < R3-C-Z2	$\lvert t_{0.05(2), 288.55} \rvert = 2.79$; $P < 0.05$
R3-PI-Z1 < R3-C-Z3	$\lvert t_{0.05(2), 380.01} \rvert = 3.65$; $P < 0.05$

Colony Density – The overall scleractinian colony density as observed in visual belt transects ranged from 0.43 to 2.37 colonies/m^2 (Table 6). Scleractinian coral colony density was lowest and most variable at Reef 2 (Table 6; Figure 9). Colony densities were highest at Reef 3 and R3-PI sites. There were significant differences in mean colony densities between zones across third reef sites (R3, R3-PI, and R3-C) (F = 3.29; P = 0.01). There were, however, no significant differences in scleractinian coral density between Reef 2 zones (t = 0.092; P > 0.50; n = 4). Results of a one-way ANOVA testing whether differences of colony density existed between R3, R3-PI and R3-C zones were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	0.179317	8	0.022415	3.299468	0.011021	2.355081
Within Groups	0.163042	24	0.006793			
Total	0.342359	32				

The multiple comparisons of mean densities between all zones across third reef sites (R3, R3-PI, and R3-C) (Tukey test, P < 0.05) showed the mean density of scleractinians at R3-C-Z2 was significantly less than at sites R3-Z1 and R3-PI-Z1.

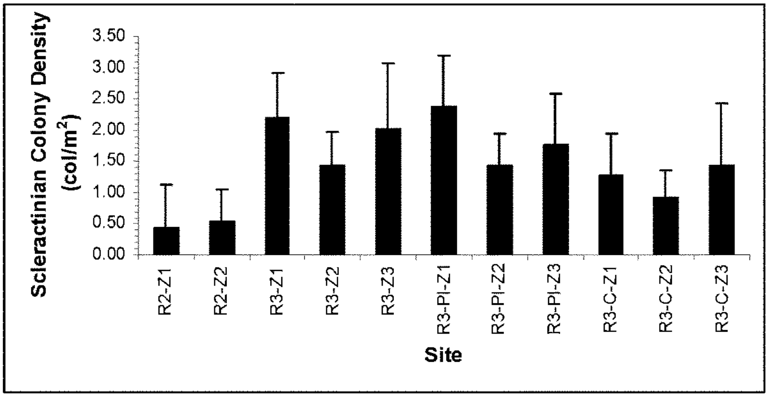

Figure 9. Scleractinian colony density (± *SD*) by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Scleractinian Colony Sizes – The size classes of scleractinians observed here were as follows: Class I = 0-3 cm; Class II = 4-10 cm; Class III = 11-25 cm; Class IV = 26-50 cm. These size classes were pre-assigned for this survey. There were no scleractinians with diameters exceeding 50 cm in diameter (Class V). Most scleractinians observed within the visual belt transects (51% to 59% of all scleractinians) belonged to size Class II (Table 10; Figure 10). Class I was the next most common size class (17% to 40% of all scleractinians).

Table 10. Distribution of the scleractinian colony sizes (diameter) by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. Sizes were organized in five size classes: Class I = 0-3 cm; Class II = 4-10 cm; Class III = 11-25 cm; Class IV = 26-50 cm; and Class V = > 50 cm. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Reef Site-Zone	Statistic	Class I	Class II	Class III	Class IV	Class V
R2-Z1	Distribution (%)	31.67	51.67	15.00	1.67	
	Colonies	19	31	9	1	0
R2-Z2	Distribution (%)	23.81	59.52	15.48	1.19	
	Colonies	20	50	13	1	0
R3-Z1	Distribution (%)	37.08	51.37	11.55	0.00	
	Colonies	122	169	38	0	0
R3-Z2	Distribution (%)	38.79	52.80	7.94	0.47	
	Colonies	83	113	17	1	0
R3-Z3	Distribution (%)	24.14	55.17	19.16	1.53	
	Colonies	63	144	50	4	0
R3-PI-Z1	Distribution (%)	40.07	54.96	4.96	0.00	
	Colonies	113	155	14	0	0
R3-PI-Z2	Distribution (%)	35.84	52.60	10.98	0.58	
	Colonies	62	91	19	1	0
R3-PI-Z3	Distribution (%)	28.17	58.69	11.27	1.88	
	Colonies	60	125	24	4	0
R3-C-Z1	Distribution (%)	16.67	69.61	10.78	2.94	
	Colonies	34	142	22	6	0
R3-C-Z2	Distribution (%)	25.76	51.52	20.45	2.27	
	Colonies	34	68	27	3	0
R3-C-Z3	Distribution (%)	32.66	53.27	13.07	1.01	
	Colonies	65	106	26	2	0

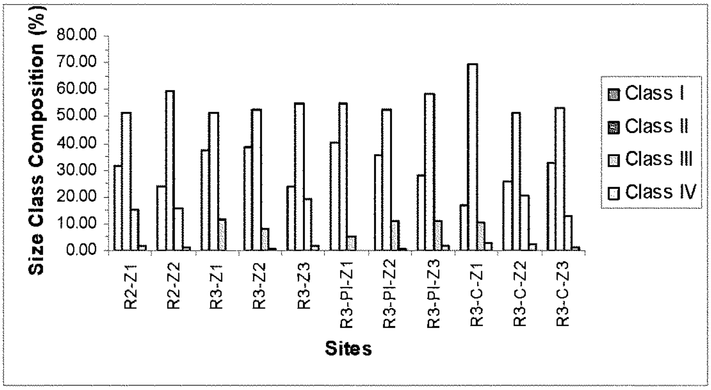

Figure 10. Distribution of scleractinian colony sizes (diameter) within reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. Class 1 = 0-3 cm; Class 2 = 4-10 cm; Class 3 = 11-25 cm; Class 4 = 26-50 cm; and Class 5 = > 50 cm. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Juvenile corals measure 0.4 cm to less than 5 cm in diameter, and adult corals measure more than 5 cm in diameter (Edmunds et al. 1998). Based on a growth rate of 1 to 3 mm per month, juvenile corals range in age from 1 to 50 months (Edmunds et al. 1998). For the purpose of this report, the scleractinian recruits and juveniles were contained within Class I. Classes II, III, and IV contained adult corals, i.e., corals capable of reproduction. Juvenile corals were not deliberately sought out and no organisms smaller than 1 cm were recorded during the visual assessment surveys.

There were no significant differences in the mean number of size Class I scleractinians between Reef 2 zones (t = 0.47; P > 0.50; n = 4). Within size Class I at third reef sites, there were significant between-zone differences of the mean number of coral colonies (F = 3.04; P < 0.016). Results of a one-way ANOVA testing whether differences of number of colonies in size Class I existed between zones were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	0.929252	8	0.116157	3.040506	0.01649	2.355081
Within Groups	0.916873	24	0.038203			
Total	1.846125	32				

The Tukey multiple means test applied between-zones and across sites showed that R3-C-Z1 had significantly less Class I colonies than R3-PI-Z1 (P < 0.05).

There were no significant differences between Reef 2 zones in the mean number of size Class II scleractinians (t = -0.26; P > 0.50; n = 4), size Class III scleractinians (t = -0.39; P > 0.50; n = 4), or size Class IV scleractinians (t = 0; P >0.50; n = 4). There were significant differences in the mean number of size Class II scleractinian colonies between zones within all third reef sites (R3, R3-PI, and R3-C) (F = 2.59; P = 0.03). There were no significant differences in the mean number of size Class III coral colonies (F = 1.83; P = 0.11). There were no significant differences in the mean number of size Class IV scleractinian colonies between zones within third reef sites (F = 0.79; P = 0.60)

Results of a one-way ANOVA testing differences in the mean number of size Class II octocoral colonies between zones within third reef sites (R3, R3-PI, and R3-C) were as follow:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	0.51103	8	0.063879	2.596341	0.03362	2.355081
Within Groups	0.590481	24	0.024603			
Total	1.101511	32				

Results of a one-way ANOVA, testing differences of mean numbers of size Class III scleractinian colonies between zones within third reef sites were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	0.258557	8	0.03232	1.836384	0.119181	2.355081
Within Groups	0.42239	24	0.0176			
Total	0.680947	32				

Results of a one-way ANOVA, testing differences of mean numbers of size Class IV scleractinian colonies between zones within third reef sites were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	0.054275	8	0.006784	0.798527	0.60963	2.355081
Within Groups	0.203906	24	0.008496			
Total	0.258181	32				

Colony Sizes by Species – Among the most common scleractinians encountered here, the diameters of most of the *S. siderea*, *S. intersepta*, and *S. radians* colonies did not exceed 10 cm (i.e., size Classes I and II) (Table 11). Colonies of *P. astreoides* and *M. cavernosa*, two other common species, had diameters that ranged mostly from 4 to 25 cm (i.e., size Classes II and III). Relatively large abundances of these corals in these size classes were recorded at R3, R3-PI, and at R3-C Zones 1 and 3.

Colony Condition – Overall, the scleractinians observed within the visual belt transects were in good condition. There were a few exceptions, some colonies were bleached, some exhibited partial mortality, and others were grown over by algae. Reef 2 had the highest incidence of these types of afflictions (12% of scleractinian colonies at R2-Z1; 6% at R2-Z2). At R3, R3-C, and R3-PI the percentage of afflicted scleractinians ranged from 2% to 3%. Species with the most afflictions were *S. siderea* and *S. intersepta,* which may be an artifact considering that these species were also the two most abundant scleractinians (Table 6). Most of the afflicted corals belonged to size Classes I (0-3 cm) and II (3-10 cm) which may also be an artifact considering that most scleractinians observed here belonged to these size classes (Figure 10). Further, Class IV (26-50 cm) corals that showed some form of affliction were found at R3-C-Z1 and R3-C-Z2 where most Class IV corals were documented (Figure 10).

Table 12 illustrates the individual incidences of afflicted/stressed corals by reef site, zone, and sampling station (RP). The diameter of each colony with an affliction is presented following the species.

3.1.3.2 Hard Corals-Hydrocorals

Other than *Millepora alcicornis*, the only other hydrocoral observed was *M. complanata* which was identified at R3-C-Z1. The colony density of *M. alcicornis* ranged from 0.01 to 0.28 colonies/m^2 (Table 13). This range of density was low compared to that of the scleractinians (0.43 to 2.37 colonies/m^2). As the visual data were being gathered, it was clear that there were few hydrocorals compared to any other sessile organisms. *M. alcicornis* was primarily seen as an encrusting form on artificial substrates such as fishing line and on skeletons of dead octocorals. Therefore, measurements of *M. alcicornis* within the belt transects consisted mostly of encrusted substrates rather than actual diameters of colonies as in the case of scleractinians. Overall, there were very few *M. alcicornis* individuals seen at Reef 2, while more individuals were documented on R3, R3-PI, and R3- C. The majority of *M. alcicornis* were size Class II (4-10 cm) individuals (Table 14).

Table 11. Distribution of the scleractinian colony sizes by species, reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. Sizes were organized in four size classes: Class I = 0-3 cm; Class II = 4-10 cm; Class III = 11-25 cm; and Class IV = 26-50 cm. Species are listed in alphabetic order. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

	R2-Z1				R2-Z2				R3-Z1				R3-Z2				R3-Z3			
Size Class	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Agaricia agaricites	0	1	0	0					1	2	1	0	0	0	1	0	1	5	2	0
Agaricia fragilis																				
Agaricia humilis																				
Agaricia lamarcki																	0	0	1	0
Colpophyllia natans					0	0	0	1												
Dichocoenia stokesii	0	1	0	0					3	1	0	0	5	3	0	0	0	2	0	0
Diploria labyrinthiformis																				
Diploria strigosa	0	0	2	0					0	0	2	0					0	0	0	1
Eusmilia fastigiata					0	1	0	0												
Favia fragum																				
Leptoseris cucullata																				
Madracis decactis	0	0	1	0	0	4	0	0	2	2	1	0	0	5	4	0	2	5	4	0
Manicina areolata																				
Meandrina meandrites	0	1	2	0	0	1	1	0	2	3	2	0	2	4	0	0	0	5	2	0
Montastraea annularis	2	3	0	0	0	3	4	0	1	1	0	0					0	1	4	0
Montastraea cavernosa	0	4	2	1	1	6	4	0	12	26	16	0	8	13	2	0	11	12	5	0
Mycetophyllia aliciae													0	0	1	1				
Mycetophyllia ferox																	0	1	0	0
Porites astreoides	0	3	0	0	0	7	1	0	9	61	13	0	2	18	0	0	1	28	18	2
Porites porites									0	4	1	0	0	1	0	0	1	1	2	0
Scolymia spp.									1	0	0	0	1	0	0	0	1	0	0	0
Siderastrea siderea	11	8	2	0	8	10	1	0	44	30	1	0	29	23	5	0	24	38	4	0
Siderastrea radians	3	3	0	0	2	3	0	0	13	15	1	0	7	10	1	0	4	8	1	0
Solenastrea bournoni																	0	0	1	0
Stephanocoenia intersepta	3	7	0	0	9	15	2	0	34	24	0	0	29	36	3	0	18	38	6	1

	R3-PI-Z1				R3-PI-Z2				R3-PI-Z3				R3-C-Z1				R3-C-Z2				R3-C-Z3			
Size Class	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Agaricia agaricites	1	0	0	0	0	1	0	0	0	2	0	0	0	1	1	0	0	0	4	1	1	3	0	0
Agaricia fragilis					0	0	1	0																
Agaricia humilis									0	1	0	0												
Agaricia lamarcki																								
Colpophyllia natans									0	0	0	1	0	0	1	0								
Dichocoenia stokesii	1	1	0	0	1	5	0	0	0	5	1	0	2	3	0	0	0	0	1	0	2	2	1	0
Diploria labyrinthiformis	0	1	0	0					0	1	0	0												
Diploria strigosa	0	1	0	0					0	0	0	2	0	0	0	1								
Eusmilia fastigiata									0	1	0	0					0	0	1	0	1	1	0	0
Favia fragum									0	1	0	0												
Leptoseris cucullata																					0	1	0	0
Madracis decactis	2	4	2	0	3	6	2	0	3	2	2	0	1	7	0	0	0	2	0	0	1	1	3	0
Manicina areolata					1	0	0	0	0	1	0	0												
Meandrina meandrites	0	2	0	0	1	2	0	0	1	2	0	0	0	2	0	0	0	1	0	0	0	1	1	0
Montastraea annularis	3	1	0	0	0	1	3	1	1	2	5	0	1	1	0	0	0	3	1	0	3	2	1	1
Montastraea cavernosa	11	8	2	0	4	12	8	0	8	8	8	1	6	23	8	2	1	6	8	2	6	12	9	1
Mycetophyllia aliciae																								
Mycetophyllia ferox	0	1	0	0									0	0	0	1								
Porites astreoides	6	47	8	0	1	13	2	0	2	28	3	0	3	48	5	1	1	15	4	0	6	19	7	0
Porites porites	5	3	0	0	0	2	0	0					0	6	0	0	2	6	2	0	5	6	1	0
Scolymia spp.					1	0	0	0																
Siderastrea siderea	44	60	2	0	21	16	1	0	28	25	4	0	8	26	4	0	15	19	3	0	18	21	0	0
Siderastrea radians	10	5	0	0	10	5	0	0	5	12	0	0	3	7	0	0	2	3	0	0	3	4	1	0
Solenastrea bournoni					0	0	1	0					0	0	2	0	1	1	1	0	0	1	1	0
Stephanocoenia intersepta	30	21	0	0	19	28	1	0	12	34	1	0	10	18	1	1	12	12	2	0	19	32	1	0

Table 12. Individual incidences of afflicted/stressed corals by reef site, zone, and sampling station (RP).

				Condition Category													
Reef Site and Zone	Random Point	Coral Species	Size (cm)	Partial Mortality	Bleached	Partial Bleaching	Pale	Patchy bleaching	Sedimentation	Distended polyps	Mucus	Cyanobacterial overgrowth	Partial overgrowth by algae	Invasion by barnacles	Invasion by Cliona	Broken	Overturned
R2-Z1	1	*Siderastraea siderea*	14	X					X								
		Montastraea cavernosa	16	X													
		Porites astreoides	8	X													
	3	*Siderastraea siderea*	5	X													
	4	*Porites astreoides*	NA							X							
		Stephanocoenia intersepta	NA							X							
		Montastraea annularis								X							
R2-Z2	1	*Siderastraea siderea*	8	X													
		Siderastraea siderea	3			X											
	2	*Montastraea cavernosa*	20	X													
	3	*Siderastraea siderea*	6	X	X												
		Stephanocoenia intersepta	4														
R3-Z1	2	*Montastraea cavernosa*	22										X				
		Siderastrea radians	20	X													
		Siderastrea siderea	2		X												
		Siderastrea radians	2.5		X												
		Siderastrea siderea	2		X												
	3	*Porites astreoides*	7	X													
		Stephanocoenia intersepta	3		X												
	4	*Stephanocoenia intersepta*	4		X												
		Siderastrea radians	6	X													
		Porites astreoides	13						X								
		Siderastrea radians	3						X								
R3-Z2	1	*Stephanocoenia intersepta*	9			X											
		Siderastrea siderea	6	X													
		Stephanocoenia intersepta	2		X												
	3	*Stephanocoenia intersepta*	4			X											
		Stephanocoenia intersepta	5		X												
R3-Z3	1	*Stephanocoenia intersepta*	7			X											
		Porites astreoides	5						X								
		Siderastrea siderea	3						X								
		Siderastrea siderea	5				X										
	2	*Stephanocoenia intersepta*	5	X													
		Agaricia agaricites	6			X											
	3	*Siderastrea siderea*	4		X												
R3-PI-Z1	1	*Stephanocoenia intersepta*	3		X												
		Siderastrea siderea	4		X												
		Siderastrea siderea	5			X											
		Siderastrea siderea	4			X											
	2	*Stephanocoenia intersepta*	2		X												
		Siderastrea siderea	5			X											
		Siderastrea siderea	2				X										
R3-PI-Z2	1	*Stephanocoenia intersepta*	3		X												
		Siderastrea radians	3		X												
	2	*Siderastrea siderea*	4		X												
		Stephanocoenia intersepta	4		X												
		Stephanocoenia intersepta	3		X												
		Stephanocoenia intersepta	3		X												
		Stephanocoenia intersepta	5	X													
	3	*Stephanocoenia intersepta*	4	X		X											
R3-PI-Z3	1	*Siderastrea radians*	4	X													
		Siderastrea siderea	2									X					
		Siderastrea siderea									X						
	2	*Montastraea cavernosa*	14											X			
		Stephanocoenia intersepta	4			X											
		Stephanocoenia intersepta	7	X													
R3-C-Z1	1	*Montastraea cavernosa*	30					X									
		Montastraea cavernosa	40												X		
	4	*Porites astreoides*	10	X													
		Porites astreoides	35	X													
		Montastraea cavernosa	23													X	X
R3-C-Z2	2	*Montastraea cavernosa*	30													X	
	3	*Montastraea cavernosa*	22												X		
R3-C-Z3	1	*Eusmilia fastigiata*	5													X	
		Siderastrea siderea	4		X												
		Stephanocoenia intersepta	6					X									
		Stephanocoenia intersepta	6					X									
	3	*Siderastrea siderea*	3		X												

Table 13. Distribution of *Millepora* colony sizes by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. Sizes were organized in four size classes: Class I = 0-3 cm; Class II = 4-10 cm; Class III = 11-25 cm; and Class IV = 26-50 cm. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Site	Colonies	Mean Density (colonies/m^2)	*SD*	*N*
R2-Z1	5	0.04	0.07	14
R2-Z2	1	0.01	0.03	16
R3-Z1	42	0.28	0.27	15
R3-Z2	32	0.21	0.29	15
R3-Z3	28	0.22	0.21	13
R3-PI-Z1	26	0.22	0.23	12
R3-PI-Z2	10	0.08	0.17	12
R3-PI-Z3	23	0.19	0.19	12
R3-C-Z1	24	0.15	0.14	16
R3-C-Z2	9	0.06	0.13	14
R3-C-Z3	15	0.11	0.16	14

Table 14. Distribution of *Millepora alcicornis* colony sizes by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. Sizes were organized in four size classes: Class I = 0-3 cm; Class II = 4-10 cm; Class III = 11-25 cm; and Class IV = 26-50 cm. Species are listed in alphabetic order. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Site	R2-Z1				R2-Z2				R3-Z1				R3-Z2			
Size Class	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
M. alcicornis	0	4	1	0	0	1	0	0	8	22	9	3	6	19	6	1
M. complanata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site	R3-Z3				R3-PI-Z1				R3-PI-Z2				R3-PI-Z3			
Size Class	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
M. alcicornis	1	14	11	2	8	14	4	0	0	6	4	0	6	10	6	1
M. complanata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site	R3-C-Z1				R3-C-Z2				R3-C-Z3			
Size Class	I	II	III	IV	I	II	III	IV	I	II	III	IV
M. alcicornis	5	18	0	1	0	7	1	1	4	7	4	0
M. complanata	0	4	0	0	0	0	0	0	0	0	0	0

3.1.3.3 Octocorals

Octocoral Genera – Thirteen genera of octocorals were found within the visual belt transects (Table 15). The most common and abundant octocoral genus was *Briareum*, mostly in the encrusting form. Other common and abundant genera were *Pseudopterogorgia* and *Plexaura*.

At Reef 2, the mean number of octocoral genera was not significantly different between sampling zones (t = 0.12; P > 0.50; n = 4). Similarly, at third reef sites (R3, R3-PI, and R3-C), the mean number of octocoral genera was not significantly different (F = 1.75; P = 0.13).

Table 15. Number of octocoral colonies by genus, reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. Genera are listed in alphabetic order. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Genus	R2		R3			R3-PI			R3-C		
	Z1	Z2	Z1	Z2	Z3	Z1	Z2	Z3	Z1	Z2	Z3
Briareum	20	17	56	106	62	4	34	44	32	40	14
Ellisella	0	0	0	0	0	0	1	0	1	0	0
Erythropodium	0	0	0	0	1	1	0	0	0	0	19
Eunicea	2	5	5	7	25	1	3	0	6	15	5
Gorgonia	0	1	0	0	0	0	0	0	0	0	0
Iciligorgia	0	0	0	1	0	0	0	0	1	0	0
Muricea	2	2	5	5	1	0	0	0	5	8	0
Muriceopsis	0	0	0	0	1	1	2	0	0	0	0
Plexaura	11	8	34	24	38	2	2	1	10	5	16
Plexaurella	0	1	0	0	0	0	0	0	0	0	3
Pseudoplexaura	1	1	8	6	7	0	2	0	2	5	2
Pseudopterogorgia	21	6	82	56	71	2	7	0	57	18	33
Pterogorgia	1	0	1	0	12	0	0	0	76	15	0

Results of a one-way analysis of variance (ANOVA) testing differences of the mean number of octocoral genera between zones within third reef sites (R3, R3-PI, and R3-C) were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	0.455646	8	0.056956	1.754137	0.136861	2.355081
Within Groups	0.779265	24	0.032469			
Total	1.23491	32				

Colony Density – The octocoral colony density as observed in visual belt transects was highly variable within each site and ranged from 0.09 to 1.68 colonies/m^2 (Table 16; Figure 11). Zones that had comparatively higher octocoral densities were those in R3 and R3-C.

There were no significant differences between the mean densities of octocorals at Reef 2 zones (t=0.56; P> .50; n=4). There were no significant differences in densities of octocoral colonies among zones within third reef sites (R3, R3-PI, and R3-C) (F=1.40; P=0.24). Results of a one-way ANOVA testing differences of colony density between zones within third reef sites were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	0.325348	8	0.040669	1.409348	0.242932	2.355081
Within Groups	0.69255	24	0.028856			
Total	1.017898	32				

Table 16. Number of octocoral colonies and genera, and density of colonies by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. [*SD* = standard deviation; R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Reef Site-Zone	Colonies	Genera	Mean Density (colonies/m^2)	*SD*
R2-Z1	58	7	0.41	0.40
R2-Z2	41	7	0.26	0.31
R3-Z1	230	7	1.27	1.41
R3-Z2	253	7	1.37	1.08
R3-Z3	254	9	1.68	1.60
R3-PI-Z1	22	6	0.09	0.09
R3-PI-Z2	73	7	0.43	0.52
R3-PI-Z3	54	2	0.38	0.56
R3-C-Z1	190	7	1.19	0.59
R3-C-Z2	106	7	0.76	0.70
R3-C-Z3	92	7	0.66	0.77

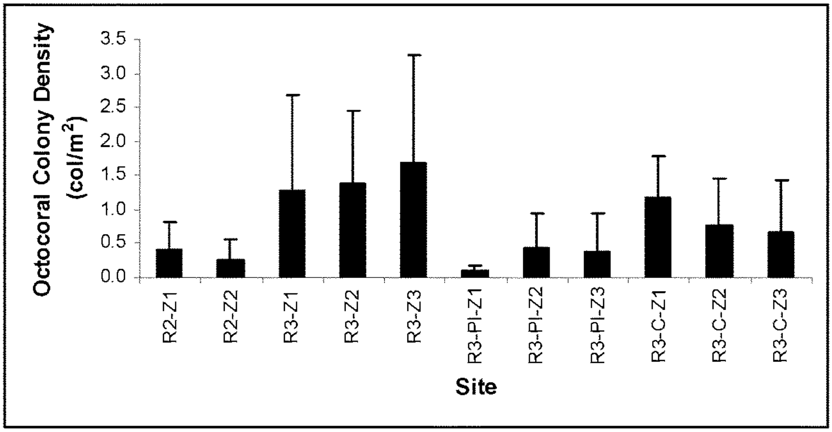

Figure 11. Mean octocoral colony density (± *SD*) by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Colony Size Classes – The pre-assigned size classes of octocorals observed here were as follows: Class I = 0-10 cm; Class II = 11-25 cm; Class III = 26-50 cm; Class IV = > 50 cm. Most octocorals (36% to 58% of all octocorals) belonged to size Class II (Table 17; Figure 12). Class I was the next most abundant class size (19% to 45% of all octocorals).

Table 17. Distribution of the octocoral colony sizes (height) by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. Sizes were organized in five size classes: Class I = 0-10 cm; Class II = 11-25 cm; Class III = 26-50 cm; Class IV = > 50 cm. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Reef Site-Zone	Statistic	Class I	Class II	Class III	Class IV
R2-Z1	Distribution (%)	18.97	50.00	20.69	10.34
	Colonies	11	29	12	6
R2-Z2	Distribution (%)	26.83	48.78	21.95	2.44
	Colonies	11	20	9	1
R3-Z1	Distribution (%)	36.13	50.79	11.52	1.57
	Colonies	69	97	22	3
R3-Z2	Distribution (%)	33.33	44.12	22.06	0.49
	Colonies	68	90	45	1
R3-Z3	Distribution (%)	24.31	57.80	16.06	1.83
	Colonies	53	126	35	4
R3-PI-Z1	Distribution (%)	45.45	36.36	18.18	0.00
	Colonies	5	4	2	0
R3-PI-Z2	Distribution (%)	37.25	37.25	21.57	3.92
	Colonies	19	19	11	2
R3-PI-Z3	Distribution (%)	35.56	53.33	11.11	0.00
	Colonies	16	24	5	0
R3-C-Z1	Distribution (%)	41.58	40.00	15.79	2.63
	Colonies	79	76	30	5
R3-C-Z2	Distribution (%)	42.45	38.68	15.09	3.77
	Colonies	45	41	16	4
R3-C-Z3	Distribution (%)	23.91	52.17	20.65	3.26
	Colonies	22	48	19	3

Within size Class I, there were no significant differences between zones within third reef sites (R3, R3-PI, and R3-C) in the mean number of octocoral colonies ($F = 2.23$; $P = 0.06$). The same was true for size Class I octocorals at Reef 2 zones ($t = 0.12$; $P > 0.50$; $n = 4$). The results of one-way ANOVA of mean number of size Class I octocorals at zones within third reef sites were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	1.204249	8	0.150531	2.232365	0.063096	2.374812
Within Groups	1.550919	23	0.067431			
Total	2.755168	31				

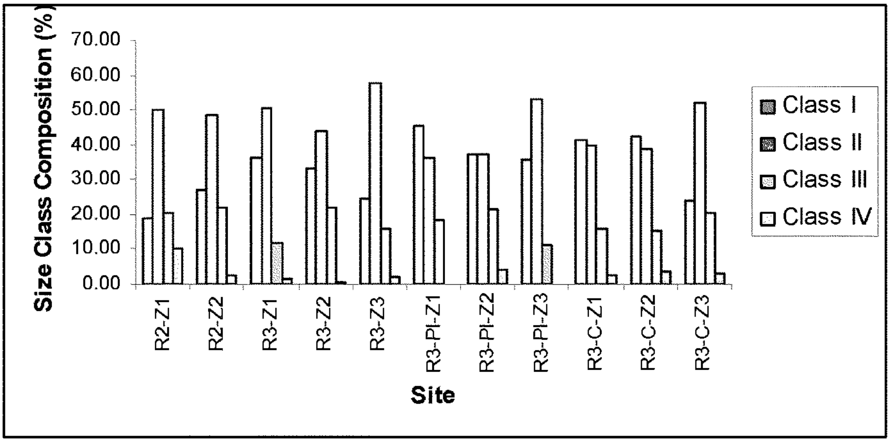

Figure 12. Distribution of octocoral colony sizes (height) within reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. Class I = 0-10 cm; Class II = 11-25 cm; Class III = 26-50 cm; Class IV = > 50 cm. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

There were no significant differences in the mean number of size Class II octocoral colonies either between Reef 2 zones (t = 0.59; P > 0.50; n = 4) or zones within third reef sites (R3, R3-PI, and R3-C) (F = 1.51; P = 0.20). Further, there were no differences in size Class III octocorals between Reef 2 zones (t = 0.37; P > 0.50. n = 4) and between zones within third reef sites (R3, R3-PI, and R3-C) (F = 1.49; P = 0.20). There were no significant differences in the mean number of octocoral colonies of size Class IV between Reef 2 zones (t = 0.82; P > 0.50; n =4) or between zones within third reef sites (R3, R3-PI, and R3-C) (F = 0.70; P = 0.68).

Results of a one-way ANOVA, testing differences in the mean number of size Class II octocoral colonies between zones within third reef sites (R3, R3-PI, and R3-C) were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	1.488397	8	0.18605	1.516655	0.203546	2.355081
Within Groups	2.944105	24	0.122671			
Total	4.432502	32				

Results of a one-way ANOVA, testing differences in the number of size Class III octocoral colonies between zones within third reef sites (R3, R3-PI, and R3-C) were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	0.716978	8	0.089622	1.4982	0.209864	2.355081
Within Groups	1.435678	24	0.05982			
Total	2.152656	32				

Results of a one-way ANOVA testing differences in the number of size Class IV octocoral colonies between zones within third reef sites (R3, R3-PI, and R3-C) were as follows:

Source of Variation	SS	DF	MS	F	P-value	F crit
Between Groups	0.04304	8	0.00538	0.708342	0.68165	2.355081
Within Groups	0.182284	24	0.007595			
Total	0.225323	32				

3.1.3.4 Sponges

Within the belt transects, records were kept on the occurrence of sponge genera, the abundance and height of the barrel sponge (*X. muta*), and the presence of the coral excavating and encrusting sponge *Cliona delitrix*. In many cases, the barrel sponge added relief to surveyed hardbottom communities.

A total of 22 sponge genera were observed among all sites (Table 18). There were ten genera common to almost every sampling site: *Agelas*, *Aplysina*, *Callyspongia*, *Cliona*, *Iotrochota*, *Ircina*, *Monanchora*, *Niphates*, *Verongula*, and *Xestospongia* (Table 18). Note that *Anthosigmella varians* was recently reclassified as *Cliona varians*. During the survey, records were purposefully kept on the occurrence of "*Anthosigmella*" to differentiate them from the occurrence of coral excavating *C. delitrix*. Reef 3 (R3) contained the greatest number of sponge genera (20), and R3-C contained the least (14). No sponges were collected for identification purposes. The identification of sponges was done while in the field and from photographs, therefore identification to genus level was considered sufficient, since species level differences often require microscopic analysis.

The barrel sponge occurred at each sampling location, except R2-Z1 (Table 18). *Cliona* spp. occurred in 17 of the 153 belt transects (~11%) and in nine of the 11 sampling zones (not observed at R3-PI-Z1 or R3-C-Z1) (Table 18). The density of *X. muta* varied from 0 to 0.21 colonies/m^2 (Table 19; Figure 13). The density of barrel sponges was highly variable because of the relatively low number of individuals found. The largest number of barrel sponges was found at R3 (Figure 14). Further, compared to all other sampling sites, R3 contained the largest number of *X. muta* colonies in size Class I (height ≤ 25 cm). Class II (16-50 cm) barrel sponges were absent only at R2-Z1. Class III (> 50 cm) colonies were found at the following zones: R2-Z2, R3-Z1, R3-C-Z1 and R3-C-Z2 (Figure 14).

3.1.3.5 Zoanthids

The zoanthid *Palythoa caribaeorum* occurred everywhere except at R2-Z2 and R3-PI-Z2 (Figure 15). R3-Z1 contained the greatest number of *P. caribaeorum* colonies; their sizes ranged from less than 25 cm in diameter to more than 50 cm in diameter (Figure 15). Most of the *P. caribaeorum*, however, were less than 25 cm in diameter. Overall, there were low abundances of *P. caribaeorum* compared to other sessile benthic organisms.

Table 18. Occurrence of sponge genera off Port Everglades in March 2006 by reef site and zone. Presence is indicated by an "x." [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Genus	R2		R3			R3-PI			R3-C		
	Z1	Z2	Z1	Z2	Z3	Z1	Z2	Z3	Z1	Z2	Z3
Agelas	x	x	x	x	x	x	x	x	x	x	x
Amphimedon	x		x	x	x	x	x	x	x	x	x
Aplysina	x	x	x	x	x		x	x	x	x	x
Callyspongia	x	x	x	x	x		x	x	x	x	x
Calyx							x				
Clathria		x									
Cliona delitrix	x	x	x	x	x		x	x		x	x
Cliona varians	x	x	x	x	x		x	x	x	x	x
Ectyoplasia			x		x				x		
Geodia			x	x	x	x			x		
Halisarca				x				x			
Holopsamma		x		x				x			
Iotrochota	x	x	x	x	x		x	x	x	x	x
Ircina	x	x	x		x	x	x	x	x	x	x
Monanchora	x	x	x	x	x	x	x	x		x	x
Mycale	x	x	x	x	x		x	x	x	x	x
Niphates	x	x	x	x	x	x	x	x	x	x	x
Pseudoceratina		x	x	x	x		x	x			
Siphonodictyon			x	x				x			
Strongylacidon	x	x	x	x			x				
Ulosa		x	x	x	x	x	x	x	x		
Verongula	x	x	x	x	x	x	x	x	x	x	x
Xestospongia		x	x	x	x	x	x	x	x	x	x

Table 19. Mean colony density of *Xestospongia muta* (barrel sponge) by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Reef Site-Zone	Mean Density (Colonies/m^2)	*SD*	*N*
R2-Z1	0		14
R2-Z2	0.06	0.13	16
R3-Z1	0.17	0.24	15
R3-Z2	0.21	0.22	15
R3-Z3	0.14	0.11	13
R3-PI-Z1	0.10	0.10	12
R3-PI-Z2	0.06	0.07	12
R3-PI-Z3	0.14	0.14	12
R3-C-Z1	0.04	0.06	16
R3-C-Z2	0.08	0.11	14
R3-C-Z3	0.09	0.12	14

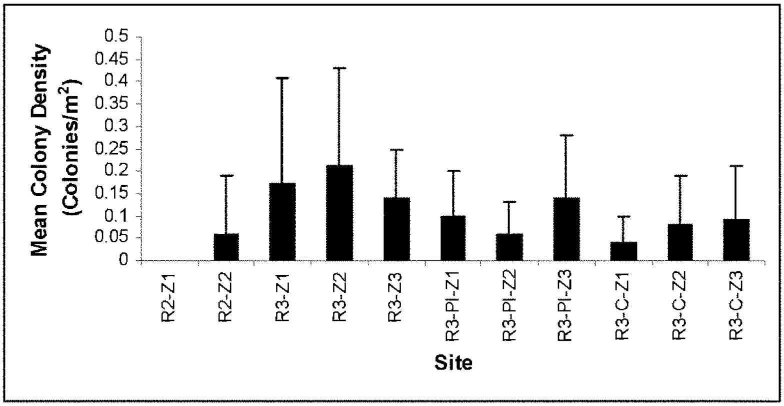

Figure 13. ***Xestospongia muta*** **(barrel sponge) colony density (±** ***SD*****) by reef site and zone as encountered in visual belt transects off Port Everglades in March 2006. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]**

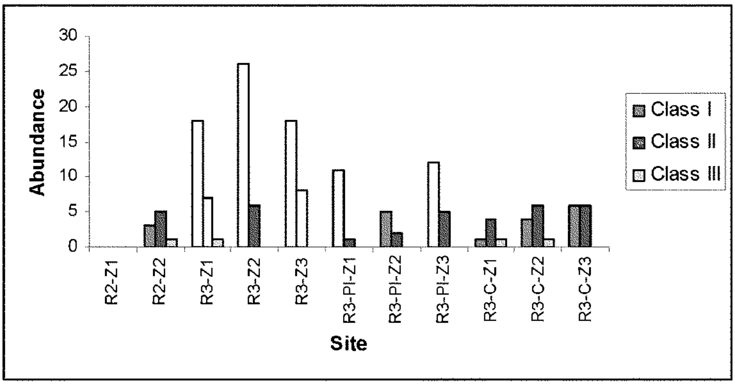

Figure 14. Abundance of barrel sponges (*Xestospongia muta*) by size class (height) and by reef site and zone as recorded in visual belt transects off Port Everglades in March 2006. Class I = 0-25 cm; Class II = 16-50 cm; Class III = > 50 cm. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

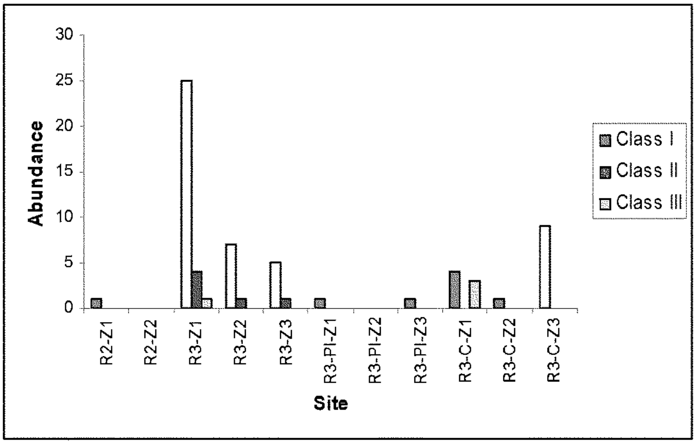

Figure 15. Abundance of the zoanthid *Palythoa caribaeorum* by size class (diameter) and by reef site and zone as recorded in visual belt transects off Port Everglades in March 2006. Class I = 0-25 cm; Class II = 16-50 cm; Class III = > 50 cm. [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

3.1.3.6 Algae

While the focus of the visual belt transects was sessile invertebrates (scleractinians, hydrocorals, octocorals, and sponges), the presence of algae was also recorded. In particular, the occurrence of *Lyngbya* was recorded, since this is cyanobacteria known to smother octocorals and other sessile organisms found on the second and third reefs (Paul et al. 2005). Such smothering occurs primarily during summer *Lyngbya* blooms. Yet, massive *Lyngbya* overgrowth of reef organisms can persist throughout the year. Cyanobacteria sampled within the general study area in December 2003 consisted of four species, the dominant being *Lyngbya confervoides* (Paul et al. 2005). During the course of this study, *Lyngbya* was not abundant and was not smothering sessile reef organisms. *Lyngbya* was seen, however, on a few octocorals at R2-Z1, R3-PI-Z1, R3-C-Z1, and R3-C-Z3 (Table 20). Lumps of what appeared to be cyanobacteria measuring approximately 10 cm in diameter were also seen covering the seafloor in a few areas: R3-Z3, R3-PI-Z1, R3-C-Z1, and R3-C-Z3 (Table 20).

Other algae observed within the belt transects included turf algae and macroalgae. Turf algae were present in all study sites. Macroalgae present in all sites were *Dictyota*. There were few observations made of other macroalgae. R3-C contained the greatest variety of macroalgae including *Schizothrix*, *Halimeda*, *Dictyota*, and *Hydroclathrus* (Table 20).

Table 20. Occurrence of algae (genus) by reef site and zone as recorded in visual belt transects off Port Everglades in March 2006. Presence is indicated by an "x." [R = Reef; Z = Zone; PI = Previously Impacted; C = Control]

Reef Site	R2		R3			R3-PI			R3-C		
Zone	**Z1**	**Z2**	**Z1**	**Z2**	**Z3**	**Z1**	**Z2**	**Z3**	**Z1**	**Z2**	**Z3**
Turf Algae	x	x	x	x	x	x	x	x	x	x	x
Lyngbya	x					x			x		x
Macroalgae											
Schizothrix					x			x	x	x	
Udotea					x						
Halimeda										x	
Dictyota	x	x	x	x	x	x	x	x	x	x	x
Hydroclathrus									x		

3.2 Benthic Organisms – Videographic Assessment

3.2.1 Comparisons of Percent Cover of Functional Groups Within and Between Reefs

Video transect data revealed that the majority of cover at sites surveyed consisted of algae and bare space. Video transect data revealed the greatest amount of substratum across sites were covered by turf algae, ranging from 31% to 61% cover (Table 21). The second largest contributor to substrate cover was sediment and rubble, or bare space (27% to 44%) (Figure 16). Macroalgae, sponges, octocorals, scleractinians, tunicates, hydrozoans, and zoanthids followed in abundance (Figure 16). This section presents benthic cover data for scleractinian corals, hydrocorals (*Millepora* spp.), octocorals, sponges, macroalgae, turf algae, and rubble and sediment categories, including results of statistical analyses. Statistical analyses included ANOVA, Tukey multiple means test, and Pearson's Correlation. While coral species-specific cover data are presented here, statistics were not used to analyze this benthic component because values were too low and variable across zones and sites (Table 22). Appendix B contains the video transect data gathered during the survey period of March 14-26, 2006.

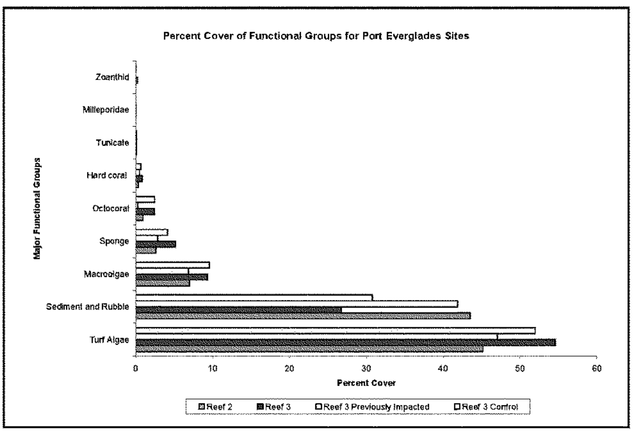

Figure 16. Mean percent cover data for nine functional groups at four reef sites as recorded in video belt transects off Port Everglades in March 2006.

Table 21. Percent cover of functional group categories as recorded in video belt transects off Port Everglades in March 2006 [*SE* = standard error; Values do not add up to 100% because "other" and "unknown" categories of cover are not presented]

Reef 2	Zone 1		Zone 2		Zone 3	
	Percent Cover	*SE*	Percent Cover	*SE*		
Hard coral	0.30	0.06	0.41	0.16	No Zone 3 for Reef 2	
Milleporidae	0.02	0.02	0.00	0.00		
Octocoral	1.56	0.68	0.35	0.13		
Sponge	1.89	0.39	3.35	1.09		
Macroalgae	6.74	1.67	7.23	2.18		
Turf Algae	59.30	3.22	31.09	5.31		
Zoanthid	0.02	0.02	0.00	0.00		
Tunicate	0.03	0.02	0.13	0.07		
Sediment	16.92	4.10	38.60	9.59		
Rubble	12.99	3.42	18.50	6.02		
Reef 3	**Zone 1**		**Zone 2**		**Zone 3**	
	Percent Cover	***SE***	**Percent Cover**	***SE***	**Percent Cover**	***SE***
Hard coral	0.74	0.12	0.76	0.19	1.15	0.24
Milleporidae	0.10	0.04	0.04	0.02	0.07	0.04
Octocoral	2.29	0.65	2.03	0.44	3.09	0.83
Sponge	5.87	0.55	4.97	0.56	4.71	0.68
Macroalgae	10.21	0.92	10.10	1.29	7.68	2.82
Turf Algae	60.93	1.92	52.37	2.14	50.56	4.53
Zoanthid	0.62	0.45	0.05	0.05	0.08	0.06
Tunicate	0.14	0.04	0.07	0.04	0.04	0.02
Sediment	12.29	2.10	27.24	3.63	27.88	6.09
Rubble	6.37	2.72	2.15	0.40	4.34	1.14
Reef 3 Previously Impacted	**Zone 1**		**Zone 2**		**Zone 3**	
	Percent Cover	***SE***	**Percent Cover**	***SE***	**Percent Cover**	***SE***
Hard coral	0.34	0.10	0.44	0.13	0.74	0.25
Milleporidae	0.04	0.04	0.02	0.02	0.02	0.02
Octocoral	0.18	0.09	0.44	0.19	0.25	0.18
Sponge	3.23	0.67	2.27	0.42	3.10	0.49
Macroalgae	7.73	3.04	4.39	0.99	8.54	2.68
Turf Algae	52.60	3.49	42.76	2.59	45.91	4.28
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00
Tunicate	0.07	0.04	0.10	0.05	0.15	0.08
Sediment	18.19	4.89	17.72	6.40	8.04	3.42
Rubble	17.09	3.22	31.66	6.57	32.93	6.65
Reef 3 Control	**Zone 1**		**Zone 2**		**Zone 3**	
	Percent Cover	***SE***	**Percent Cover**	***SE***	**Percent Cover**	***SE***
Hard coral	1.00	0.16	0.53	0.13	0.50	0.12
Milleporidae	0.00	0.00	0.03	0.02	0.00	0.00
Octocoral	3.50	0.54	1.98	0.72	1.95	0.55
Sponge	4.72	1.02	3.78	0.48	3.94	0.55
Macroalgae	10.31	2.04	8.92	1.12	9.49	1.03
Turf Algae	52.39	2.62	52.84	3.14	50.66	2.92
Zoanthid	0.11	0.09	0.04	0.04	0.00	0.00
Tunicate	0.18	0.07	0.03	0.02	0.12	0.04
Sediment	6.96	2.51	30.49	4.45	15.13	3.62
Rubble	20.57	4.69	1.12	0.24	18.10	5.16

Table 22. Scleractinian corals and the hydrocoral *Millepora alcicornis* percent-cover per reef site and zone as recorded in video belt transects off Port Everglades in March 2006.

Species	R2-Z1	R2-Z2	R3-Z1	R3-Z2	R3-Z3	R3-PI-Z1	R3-PI-Z2	R3-PI-Z3	R3-C-Z1	R3-C-Z2	R3-C-Z3
Agaricia agaricites	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agaricia humilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agaricia lamarcki	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colpophyllia natans	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0
Coral (general)	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Dichocoenia stokesii	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0
Diploria strigosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Madracis decactis	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Madracis mirabilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meandrina meandrites	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Millepora alcicornis	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Montastraea annularis complex	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.0	0.2
Montastraea cavernosa	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.2	0.3	0.2	0.1
Mycetophyllia aliciae	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Porites astreoides	0.0	0.0	0.2	0.1	0.2	0.1	0.0	0.0	0.1	0.1	0.1
Siderastrea siderea	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
Siderastrea radians	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solenastrea bournoni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Stephanocoenia intersepta	0.1	0.1	0.0	0.1	0.2	0.1	0.0	0.1	0.1	0.0	0.0

3.2.1.1 Scleractinians

Hard corals were low in cover across sites, but were highest at R3 (1.15%), followed by R3-C and R3-PI sites (Table 21). Within Reef 3, coral cover was highest at R3-Z3 (Figure 17). Results of the nested ANOVA showed that there were significant differences in scleractinian coral cover between zones within sites (F=3.57, P=0.0003). A Tukey multiple means test showed no differences between zones within sites for scleractinian coral cover. Tukey multiple means test results for coral cover data between zones across sites did show significant differences across sites for Zones 1 and 3. R3-C-Z1 had significantly higher coral cover compared to R2-Z1 and R3-PI-Z1 (P<0.05); and R3-Z1 had significantly more coral cover than R2-Z1 (P<0.05). R3-Z3 coral cover was significantly higher than R3-C-Z3 (P<0.05).

Results of ANOVA (zones nested within site), testing the difference in percent cover of scleractinian corals were as follows:

Source of Variation	SS	DF	MS	F	Pr > F
Model	3.46362417	10	0.34636242	3.57	0.0003
Error	14.34780966	148	0.09694466		
Corrected Total	17.81143383	158			

<u>*Montastraea annularis* species complex</u>
Percent cover of the *Montastraea annularis* species complex was highest at R3-C, but varied across zones (Figure 18). In contrast, Reef 2 had the lowest cover of the *M. annularis* complex. *M. annularis* complex cover appeared to increase with depth at all sites, except R3-C and Reef 2.

<u>*Montastraea cavernosa*</u>
M. cavernosa cover was highest at R3-C and declined with depth (Figure 18). At R3-PI, *M. cavernosa* showed the opposite pattern and increased with depth, while cover was similar across depths at Reef 3 and Reef 2.

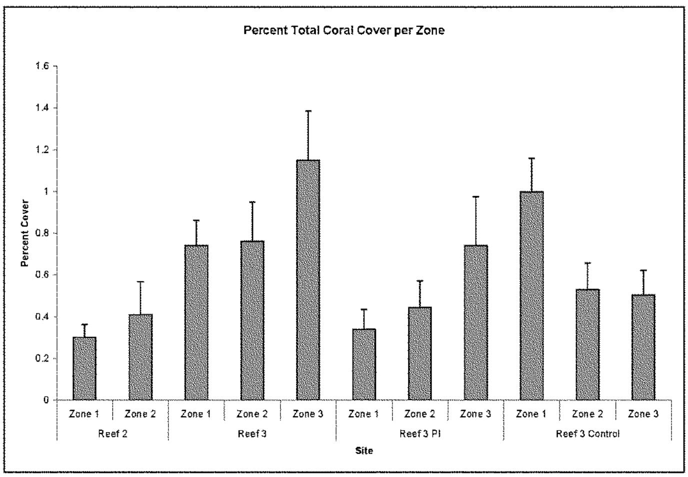

Figure 17. Percent cover for hard coral category at each reef site and zone (± *SE*) as recorded in video belt transects off Port Everglades in March 2006.

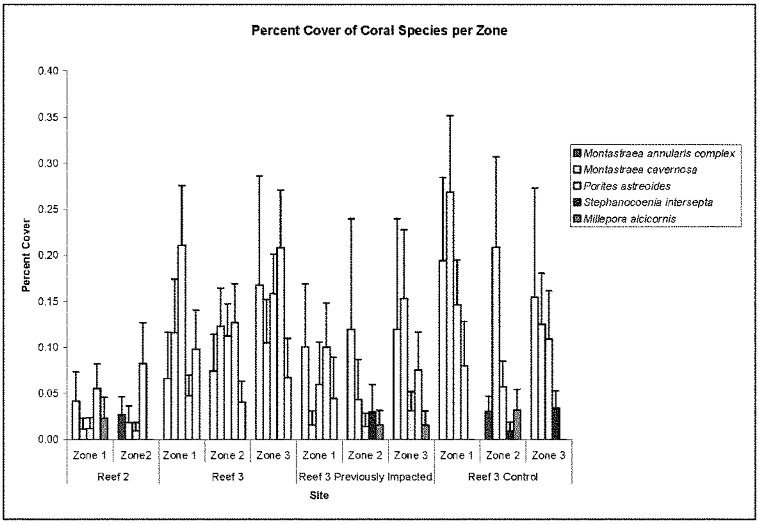

Figure 18. Percent cover of five dominant coral species at each reef site and zone (± *SE*) as recorded in video belt transects off Port Everglades in March 2006.

Porites astreoides
P. astreoides was highest in cover at R3. The control site R3-C-Z3 had lower *P. astreoides* cover than R3-Z3. Between the previously impacted site and the control site, R3-PI-Z1 had lower *P. astreoides* cover than R3-C-Z1. Within the previously impacted sites R3-PI-Z1 was higher in *P. astreoides* cover than R3-PI-Z2 (Table 22).

Stephanocoenia intersepta
S. intersepta was highest in cover at Reef 3. *S. intersepta* cover differed between zones within Reef 3 (Figure 18).

Millepora alcicornis
M. alcicornis percent cover was low overall, ranging from 0% to 0.10% (Table 22). Percent cover of *M. alcicornis* was higher at R3 than at the R3-C. R3-Z3 was higher in *M. alcicornis* cover than R3-C-Z3, and R3-Z1 had more *M. alcicornis* cover than R3-C-Z1 (Figure 18). While differences in *M. alcicornis* cover occurred, cover never exceeded 0.10% at any site and was therefore a very small contributor to the hardbottom community (Table 22).

3.2.1.2 Shannon-Weiner Diversity Index for Coral Species

The Shannon-Weiner Index (*H'*) was used to calculate diversity for scleractinian corals and *M. alcicornis* within each zone (Table 23). Diversity was low overall and ranged from 0.26 to 0.72. The highest diversity occurred at R3-Z3 and R3-C-Z1, while the lowest diversity values were found at both R2-Z1 and R3-PI-Z1.

Table 23. Shannon-Weiner diversity Index (*H'*) calculated for corals for each reef site and zone as recorded in video belt transects off Port Everglades in March 2006.

Hard Coral and Milleporidae	R2-Z1	R2-Z2	R3-Z1	R3-Z2	R3-Z3	R3-PI-Z1	R3-PI-Z2	R3-PI-Z3	R3-C-Z1	R3-C-Z2	R3-C-Z3
Diversity (*H'*)	0.26	0.29	0.62	0.58	0.72	0.23	0.27	0.40	0.70	0.43	0.35
Richness (*S*)	9	11	15	10	11	7	10	11	12	9	7

3.2.1.3 Octocorals

Octocorals, the third most abundant group, were similarly high in cover at R3-C and R3, when compared to other sites (Figure 19). The R3-PI zones were significantly lower in octocoral cover, suggesting that R3-PI zones had indeed been previously impacted (Figure 19). A nested ANOVA showed that there were significant differences between zones within sites for octocoral cover values (F=6.72, P<0.0001). A Tukey multiple means test comparing means between zones within sites showed a significant difference between R3-C-Z1 and R3-C-Z2 (P<0.05). Tukey multiple means test results for comparison of zones across sites showed significantly less octocoral cover at R3-PI-Z1 than R3-Z1 and R3-C-Z1 (P<0.05) (Figure 20). R3-C-Z1 also had significantly more octocoral cover than R2-Z1. Results for Zone 2 showed R3-Z2 had significantly more octocoral cover than R2-Z2 or R3-PI-Z2 (P<0.05). R3-PI-Z3 had significantly less gorgonian cover than R3-Z3 or R3-C-Z3 (P<0.05).

Results of ANOVA (zones nested within site), testing the difference in percent cover of octocorals were as follows:

Source of Variation	SS	DF	MS	F	Pr > F
Model	25.66070820	10	2.56607082	6.72	<.0001
Error	56.47663512	148	0.38159889		
Corrected Total	82.13734332	158			

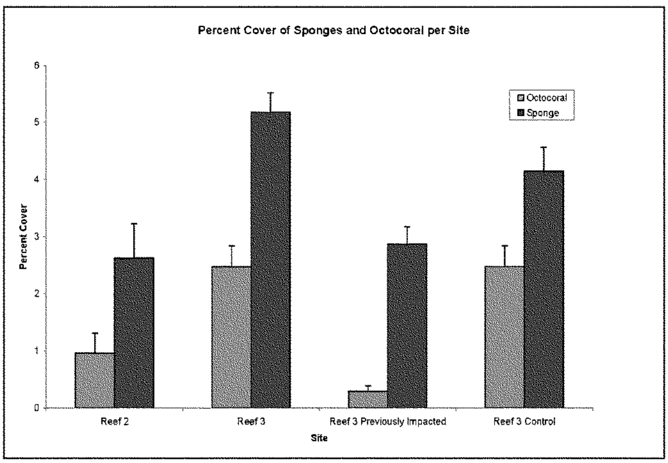

Figure 19. Mean percent sponge and octocoral cover by reef (± *SE*) as recorded in video belt transects off Port Everglades in March 2006.

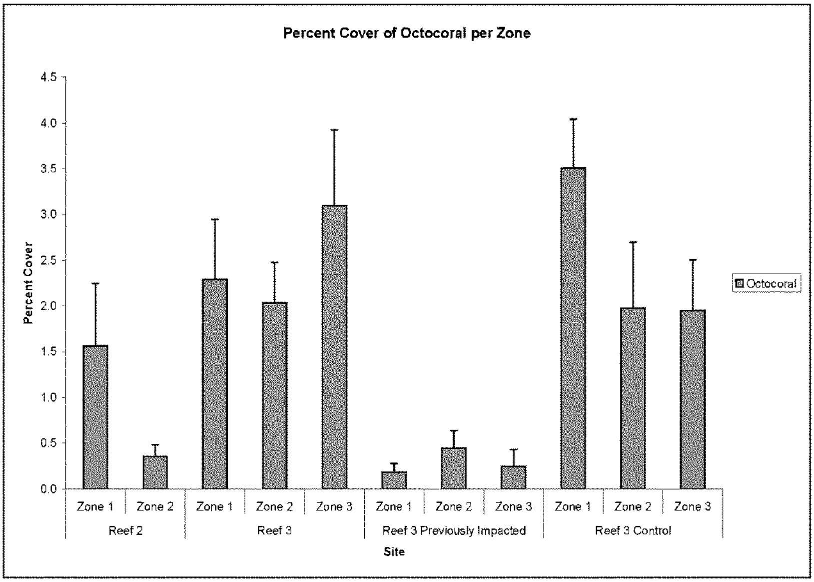

Figure 20. Mean percent octocoral cover by reef site and zone (± *SE*) as recorded in video belt transects off Port Everglades in March 2006.

3.2.1.4 Sponges

Sponges were the largest living functional group, other than the algae categories, at all sites. At R3 and R3-C, sponges had the highest cover while the lowest cover of sponges was found at Reef 2, which was similar to R3-PI (Figure 19). Results of a nested ANOVA (zones within sites), showed that there were significant differences between zones (F=4.13, P<0.0001). A Tukey multiple means test comparing zones within sites showed no differences in sponge cover data. When zones were compared across sites using a Tukey multiple means test, results were significant for Zones 1 and 2 (Figure 21). R3-Z1 had significantly higher sponge cover than R2-Z1 and R3-PI-Z1 (P<0.05). R3-C-Z1 had significantly higher sponge cover than R2-Z1 (P<0.05). In Zone 2, R3-Z2 had significantly higher sponge cover than both R3-PI-Z2 and R2-Z2 (P<0.05). In Zone 3, there were no differences found across sites.

Results of ANOVA (zones nested within site), testing the difference in percent cover of sponges were as follows:

Source of Variation	SS	DF	MS	F	Pr > F
Model	12.94436143	10	1.29443614	4.13	<.0001
Error	46.34800876	148	0.31316222		
Corrected Total	59.29237019	158			

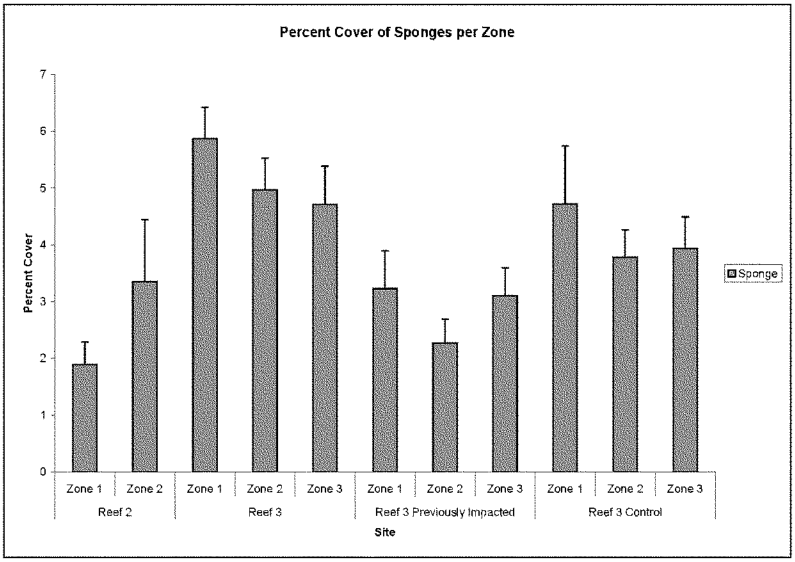

Figure 21. Mean percent sponge cover by reef site and zone (± *SE*) as recorded in video belt transects off Port Everglades in March 2006.

3.2.1.5 Macroalgae

Macroalgae ranged from 4% to 10% across sites (Table 21). Results of the nested ANOVA showed that macroalgae varied significantly across zones (F=3.14, P=0.0012). A Tukey multiple means test showed differences between zones within sites for R3, but not at any other site (P<0.05). The deepest zone, R3-Z3 had significantly less macroalgae than R3-Z1 or R3-Z2 (Figure 22). Tukey multiple means test results for means between zones across sites showed differences across all zones. R3-Z1 had significantly more macroalgae than R3-PI-Z1 (P<0.05). R3-Z2 had significantly more macroalgae than R2-Z2 (P<0.05). R3-C-Z3 had significantly higher macroalgae cover than R3-Z3 (P<0.05).

Results of ANOVA (zones nested within site), testing the difference in percent cover of Macroalgae were as follows:

Source of Variation	SS	DF	MS	F	Pr > F
Model	24.5646042	10	2.4564604	3.14	0.0012
Error	115.9562902	148	0.7834884		
Corrected Total	140.5208943	158			

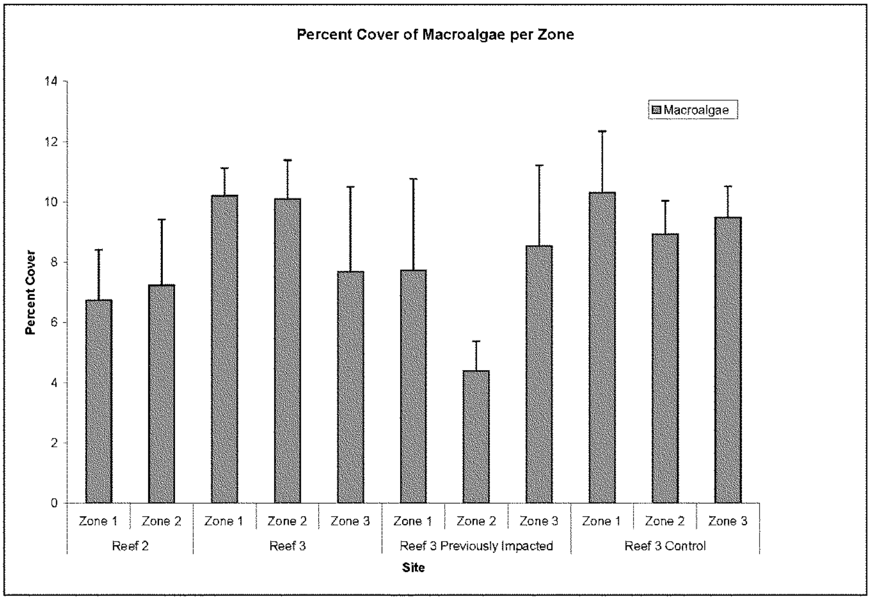

Figure 22. Mean percent macroalgae cover by reef site and zone (± *SE*) as recorded in video belt transects off Port Everglades in March 2006.

3.2.1.6 Turf Algae

The highest turf algae cover was found in Zone 1 across sites, except at site R3-C (Figure 23). Results of a nested ANOVA with zones nested within sites showed significant differences in turf cover (F=7.35, P<0.0001). A Tukeys multiple means test assessing differences between zones within sites showed that the shallower R2-Z1 had significantly higher turf cover than R2-Z2 (P<0.05). Tukey multiple means test results showed differences between zones and across sites. R2-Z2 was significantly lower than R3-Z2, R3-PI-Z2, and R3-C-Z2 (P<0.05).

Results of ANOVA (zones nested within site), testing the difference in percent cover of turf algae were as follows:

Source of Variation	SS	DF	MS	F	Pr > F
Model	9.46712079	10	0.94671208	7.34	<.0001
Error	19.07611774	148	0.12889269		
Corrected Total	28.54323853	158			

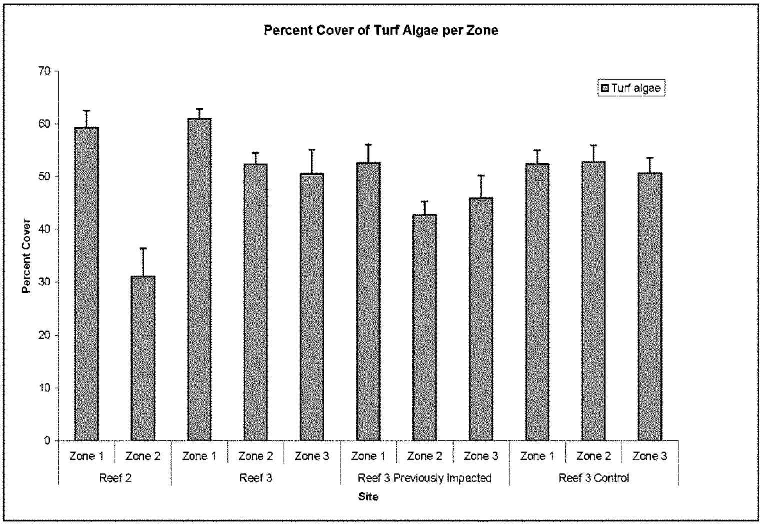

Figure 23. Mean percent turf algae cover by reef site and zone (± *SE*) as recorded in video belt transects off Port Everglades in March 2006.

3.2.1.7 Sediment and Rubble

The dominant substratum groups, rubble and sediment (sand and pavement), were combined for statistical analysis as they function together as bare space. While these benthic cover types are not devoid of life, they do function similarly to provide habitat for microbiota, sub-benthic organisms and fish. The sediment and rubble category showed spatial variability across sites, ranging from 27% to 43% cover (Figure 16). Results of the nested ANOVA showed that zones were significantly different within sites (F=4.18, P<0.0001). A Tukey multiple means test assessing differences between zones within sites for the rubble and sediment cover category showed that R2-Z2 was significantly different than R2-Z1 (P<0.05). Within site R3-PI, R3-PI-Z2 had higher cover of sediment and rubble than the shallower R3-PI-Z1, but was similar to R3-PI-Z3 (P<0.05). A Tukey multiple means test was used to look at the difference in means between zones across sites and showed significant differences between Zones 1 and 2. R3-PI-Z1 had significantly more sediment and rubble than R3-Z1 (P<0.05). R2-Z2 had significantly more sediment and rubble than both R3-C-Z2 and R3-Z2 (P<0.05), while R3-PI-Z2 had more rubble and sediment than R3-Z2 (P<0.05).

Results of ANOVA (zones nested within site), testing the difference in percent cover of sediment and rubble were as follows:

Source of Variation	SS	DF	MS	F	Pr > F
Model	14.35680624	10	1.43568062	4.18	<.0001
Error	50.82927899	148	0.34344107		
Corrected Total	65.18608523	158			

3.2.2 Pearson's Correlation Coefficient Results

Pearson's Correlations were calculated for each cover category by site, zone, and site/zone. Sand, pavement, and rubble (SPR) was found to be negatively correlated with turf algae cover at the site, zone, and site/zone levels. Sand, pavement, and rubble mentioned here is equivalent to the sediment and rubble category used above (Table 21). Macroalgae was the only other category that showed a significant negative correlation with the SPR cover category. No other positive or negative correlations were discemable through the Pearson's Correlation (Table 24). Because SPR was the dominant cover type and other cover types were so low, except for turf and macroalgae, it was difficult to interpret whether these correlations were ecologically important. Given the relatively large SPR cover, a negative correlation with turf and macroalgae was anticipated, as well as with any other cover type that was not SPR. However, because other living cover types were so low, there may not have been sufficient data for the correlation to be meaningful with respect to lower cover categories.

Table 24. Pearson's Correlation Coefficient results for the sand, pavement, rubble (SPR) category against other functional group categories based on data acquired in video belt transects off Port Everglades in March 2006. [The closer the top value was to 1 or -1, the stronger the correlation. P-values are reported underneath the correlation coefficient]

Site R2								
Pearson Correlation Coefficients, N = 31 Prob > |r| under H0: Rho=0								
	Coral	Gorgonians	Macroalgae	Millepora	Other	SPR	Sponges	Turf
SPR	-0.52352 0.0025	-0.37109 0.0399	-0.77074 <.0001	-0.13518 0.4684	-.57319 0.0008	1.00000	-0.60333 0.0003	-082202 <.0001

Site R3								
Pearson Correlation Coefficients, N = 46 Prob > |R| Under H0: Rho=0								
	Coral	Gorgonians	Macroalgae	Millepora	Other	SPR	Sponges	Turf
SPR	-0.27341 0.0660	-0.32275 0.0287	-0.63808 <.0001	-0.12540 0.4063	-0.37489 0.0103	1.00000	-0.64618 <.0001	-0.68600 <.0001
Site R3-C								
Pearson Correlation Coefficients, N = 46 Prob > |R| Under H0: Rho=0								
	Coral	Gorgonians	Macroalgae	Millepora	Other	SPR	Sponges	Turf
SPR	-0.02418 0.8733	-0.22719 0.1289	-0.57839 <.0001	0.06361 0.6745	-0.35462 0.0156	1.00000	-0.09852 0.5148	-0.70939 <.0001
Site R3-PI								
Pearson Correlation Coefficients, N = 36 Prob > |R| Under H0: Rho=0								
	Coral	Gorgonians	Macroalgae	Millepora	Other	SPR	Sponges	Turf
SPR	-0.04397 0.7990	0.06326 0.7140	-0.32059 0.0566	0.03184 0.8537	-0.43028 0.0088	1.00000	-0.48069 0.0030	-0.75831 <.0001

3.3 Reef Fish Assemblages

In total, 2323 individual fish representing 32 families and 110 species were identified during the fish assemblage surveys (Table 25). The greatest number of invidiuals were recorded at R3-PI (879 individuals). R3 and R3-C had similar numbers of fishes (603 and 550, respectively) while R2 had significantly fewer individuals (291) compared to other sites (*P* < 0.05) (Figure 24). This distribution of fish between reef tracts was similar to what had been recorded in previous studies (e.g., Ettinger et. al 2001). Figure 25 shows the distribution of fish by size class and by reef site. Fish with a total length ranging from 6 to 30 cm were most common. R3-PI supported a higher abundance of small fish compared to other sites; it also contained the largest number of juvenile fish. The prevalence of rubble and smaller rock formations at R3-PI may have supported larger numbers of juvenile fish compared to other sites. Habitat complexity may lead to the recruitment of higher numbers of juveniles, as opposed to the less rugose areas of the third reef. Table 25 shows the total number of species by location, which ranged from 47 (at R2) to 60 (at R3-C). No significant differences of fish species richness were found between sites (*P* > 0.05).

Table 25. List of fish species identified on each of the treatments March 2006

Common Name	Scientific Name	Reef 2	Reef 3	R3-PI	R3-C
Family: Stingray	**Dasyatidae**				
Yellow Stingray	*Urolophus jamaicensis*		1		1
Family: Moray Eels	**Muraenidae**				
Green Moray	*Gymnothorax funebris*			1	
Spotted Moray	*Gymnothorax moringa*	1	1	2	3
Purplemouth Moray	*Gymnothorax vicinus*				1
Goldentail Moray	*Gymnothorax miliaris*	1			
Viper Moray	*Enchelycore nigircans*			1	
Reticulated Moray	*Muraena retifera*			1	1
Family: Squirrelfishes	**Holocentridae**				
Squirrelfish	*Holocentrus adscensionis*				1
Blackbar soldierfish	*Myripristis jacobus*		6		
Family: Tilefishes	**Malacanthidae**				
Sand Tilefish	*Malacanthus plumieri*			3	
Family: Lizardfishes	**Synodontidae**				
Sand Diver	*Synodus intermedius*				1
Family Sea Basses	**Serranidae**				
Red Grouper	*Epinephelus morio*	1			2
Graysby	*Epinephelus cruentatus*		1		
Coney	*Cephalophois fulvus*				1
Sand Perch	*Diplectum formosum*	1			
Butter Hamlet	*Hypoplecturus unicolor*		5	1	1
Lantern Bass	*Serranus baldwini*	1		2	5
Tattler Bass	*Serranus phoebe*	1			
Chalk Bass	*Serranus tortugarum*			2	
Tobaccofish	*Serranus tabacarius*	5	6	5	6
Harlequin Bass	*Serranus tigrinus*	1	1	3	
Greater Soapfish	*Rypticus saponaceus*		1		
Creolefish	*Parathias furcifer*				
Family: Jacks	**Carangidae**				
Blue Runner	*Caranx crysos*	1			
Bar Jack	*Caranx ruber*	1	1	6	
Family: Snappers	**Lutjanidae**				
Yellowtail Snapper	*Ocyurus chysurus*		8		15

Common Name	Scientific Name	Reef 2	Reef 3	R3-PI	R3-C
Gray Snapper	*Lutjanus griseus*				
Mutton Snapper	*Lutjanus analis*	2	2		
Family: Drums	**Sciaenidae**				
Highhat	*Equetus acuminatus*	2	2	1	
Cubbyu	*Equetus umbrosus*				1
Family: Goatfishes	**Mullidae**				
Spotted Goatfish	*Pseudopeneus maculatus*	2	5	8	4
Family: Butterflyfishes	**Chaetodontidae**				
Spotfin Butterfly	*Chaetodon ocellatus*	4	2	2	9
Reef Butterfly	*Chaetodon sedentarius*	16	12	14	11
Foureye Butterfly	*Chaetodon capistratus*	2	3	3	6
Banded Butterfly	*Chaetodon striatus*			1	
Family: Angelfishes	**Pomacanthidae**				
Queen Angelfish	*Holocanthus cilaris*		2		5
Blue Angelfish	*Holocanthus bermundensis*	2	2	2	1
Rock Beauty	*Holocanthus tricolor*	2	1	9	6
French Angelfish	*Pomocanthus paru*	3	1		2
Gray Angelfish	*Pomocanthus arcuatus*	1	6	1	1
Cherubfish	*Centropyge argi*				1
Family: Damselfishes	**Pomacentridae**				
Bicolor Damselfish	*Stegastes paritus*	10	27	23	8
Cocoa Damselfish	*Stegastes variabilis*		3		
Beaugregory	*Stegastes leucostictus*	1		1	
Blue Chromis	*Chromis cyanus*		4	2	
Family:Wrasses	**Labridae**				
Hogfish	*Lachnolaimus maximus*	4	2	2	6
Spanish Hogfish	*Bodianus rufus*		3	2	2
Creole Wrasse	*Clepticus parrai*			200	
Clown Wrasse	*Halichoeres maculipinna*	2			4
Slippery Dick	*Halichoeres bivittatus*		1	6	
Yellowcheek Wrasse	*Halichoeres cyancephalus*	1		6	
Puddingwife	*Halichoeres radiatus*			1	
Yellowhead Wrasse	*Halichoeres garnoti*	6	24	11	15
Green Razorfish	*Xyrichtys splendens*	2			
Bluehead Wrasse	*Thalassoma bifasciatum*	51	82	110	59
Family: Parrotfishes	**Scaridae**				
Queen Parrotfish	*Scarus vetula*			1	
Princess Parrotfish	*Scarus taenipterus*		8	10	1
Bluelip Parrotfish	*Cryptotomus roseus*		4		
Greenblotch Parrotfish	*Sparisoma atomarium*	1			
Stoplight Parrotfish	*Sparisoma chrospterum*	1	9	5	2
Bucktooth Parrotfish	*Sparisoma radians*				
Redband Parrotfish	*Sparisoma aurofrenatum*	1	7	17	5
Family: Blennies	**Blennidae**				
Barred Blenny	*Hypleurochilus bermundensis*				
Roughhead Blenny	*Acanthemblemaria aspera*	8	5	2	22
Saddled Blenny	*Malacoctenus triangulatus*				2
Goldline Blenny	*Malacoctenus aurlineatus*				1
Rosy Blenny	*Malacoctenus macropus*		2	1	
Seaweed Blenny	*Parablennius marmoreus*	1			3
Family: Gobies	**Gobiidae**				
Neon Goby	*Gobisoma oceanops*				2
Yellowprow Goby	*Gobisoma xanthiprora*				1
Bridled Goby	*Coryphopterus glaucofraneum*		7	4	
Dash Goby	*Ctenogobius saepepallens*		7	6	5

Common Name	Scientific Name	Reef 2	Reef 3	R3-PI	R3-C
Colon Goby	*Coryphopterus dicrus*	2	7	5	18
Blue Goby	*Ptereleotris calliurus*	1	6	1	
Masked/Glass Goby	*Coryphopterus sp.*		25		
Family: Surgeonfishes	**Acanthuridae**				
Ocean Surgeon	*Acanthurus bahianus*	104	53	73	190
Black Durgon	*Melichtys niger*				2
Family: Scorpionfishes	**Scorpaenidae**				
Plumed Scorpionfish	*Scorpaena grandicornis*	1			
Spotted Scorpionfish	*Scorpaena plumieri*	1	2		1
Family: Leatherjackets	**Balistidae**				
Scrawled Filefish	*Aluterus scriptus*	1		1	
Orangespotted Filefish	*Cantherhines pullus*			2	
Orange Filefish	*Aluterus schoepfii*				1
Whitespotted Filefish	*Cantherhines macrocerus*	3	2		
Queen Trigger	*Balistes vetula*				3
Gray Trigger	*Balistes carpiscus*	30			13
Planehead Filefish	*Stephanolepis hispidus*			1	
Family: Boxfishes	**Ostraciidae**				
Scrawled Cowfish	*Lactrophyrus quadricornis*				
Spotted Trunkfish	*Lactrophyrus trigonus*				1
Honeycomb Cowfish	*Acanthostacion polygonia*		2		
Smooth Trunkfish	*Lactrophyrus triqueter*	1	5	2	
Family: Puffers	**Tetradontidae**				
Sharpnose Puffer	*Canthigaster rostrata*	2	4	2	2
Bandtail Puffer	*Sphoeroides splengeri*	1	3	1	
Family: Spiny Puffers	**Diodontidae**				
Porcupinefish	*Diodon hystrix*		1		1
Balloonfish	*Diodon holocanthus*	1		1	
Bridled Burrfish	*Chilomycterus antennatus*				1
Family: Grunts	**Haemulidae**				
Black Margate	*Anisotremus surinamensis*			1	
Cottonwick	*Haemulon melanurum*				1
French Grunt	*Haemulon flavolineatum*		10	1	10
Spanish Grunt	*Haemulon macrostomum*		4		
White Grunt	*Haemulon plumierii*		7		15
Porkfish	*Anisotremus virginicus*	3	1	5	1
Family: Tube Blennies	**Chaenopsidae**				
Sailfin Blenny	*Emblemaria pandionis*		1	5	
Family: Herring	*Clupeidae*				
Herring	*Harengula spp.*		150	100	
Family: Hawkfishes	**Cirrhitidae**				
Redspotted Hawkfish	*Amblycirrhitus pinos*		1		
Family: Spadefishes	**Ephippidae**				
Spadefish	*Chaetodipterus faber*		50	200	60
Family: Mackerels	**Scombridae**				
Cero Mackerel	*Scomberomous regalis*		1		2
Family: Jawfishes	**Opistognathidae**				
Banded Jawfish	*Opistognathus macrognathus*	1			1
Yellowhead Jawfish	*Opistognathus aurifrons*		4		1
Family: Dragonets	**Callionymidae**				
Lancer Dragonet	*Paradiplogrammus bairdi*				1
Family: Porgies	**Sparidae**				
Porgy	*Calamus spp.*				2
	Total Individuals	291	603	879	550
	Total Species	47	58	55	60

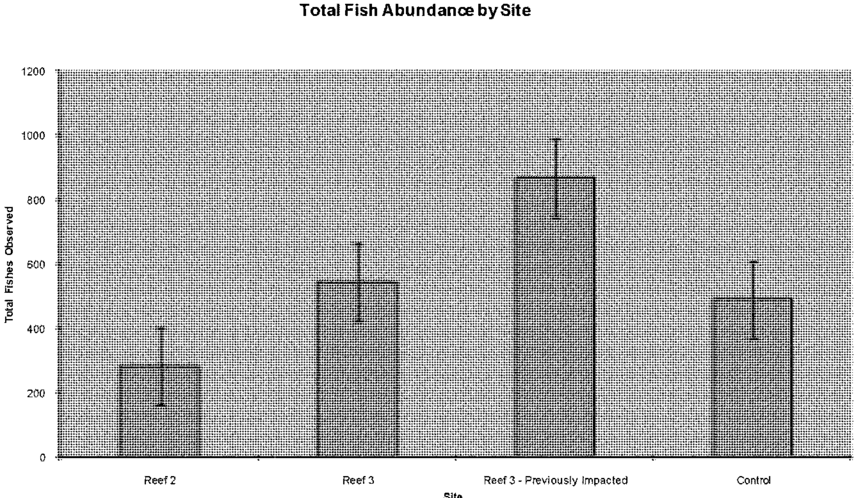

Figure 24. Total fish abundance at each site (± *SD*) as recorded in fish censuses conducted off Port Everglades in March 2006.

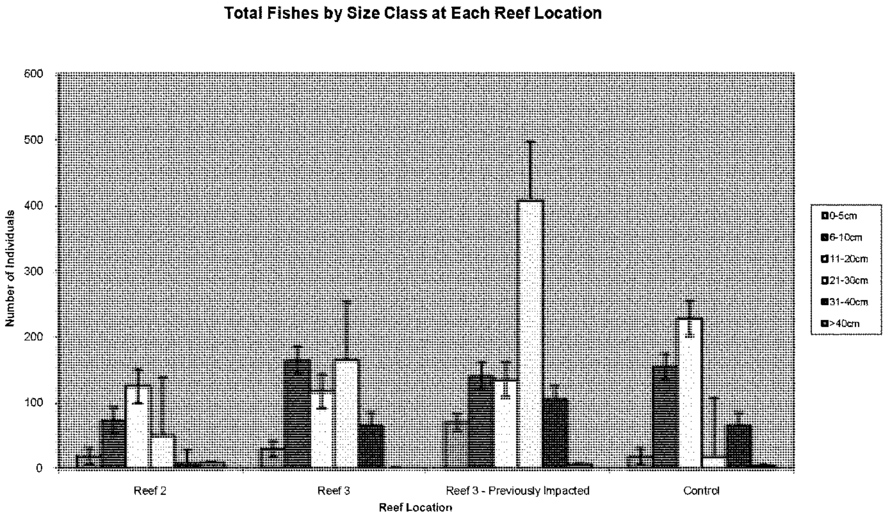

Figure 25. Total fishes by size class at each site surveyed (± *SD*) as recorded in fish censuses conducted off Port Everglades in March 2006.

4.0 DISCUSSION

The Port Everglades harbor is man-made (DEP 1999; Port Everglades.org 2009). Its development dates back to 1913 when a cut was dug out to connect Lake Mabel to the Atlantic Ocean. Lake Mabel cut was transformed into a navigation channel leading to a deepwater port starting in 1930. From 1930 to 1999, the Port Everglades navigation channel and turning basin were dredged ten separate times (DEP 1999; PortEverglades.org 2009). After nearly a century of use, the USACE is conducting a feasibility study in part to evaluate the widening and deepening of the OEC to accommodate increasingly larger vessels (deeper draft, wider beam) including cargo vessels, tankers, and cruise liners. The proposed improvements may require the widening and deepening of the existing OEC through the second reef and a seaward extension of the OEC through a section of the third reef. The environmental charaterization presented in this report was intended to help evaluate the potential impacts the proposed improvement will have on local biological communities and substrates of the second and third reefs. This report evaluated benthic organisms and fish found within representative sampling sites of the anticipated footprint of the improved OEC (i.e., R2 and R3) and of the area adjacent to the improved OEC (R3-PI, R3-C).

There is siginificant variability in benthic communities between second and third reefs off Broward County (Moyer et al. 2003; Gilliam et al. 2006; this study). Yet, all studies consistently show that the third reef is more developed biologically than the second reef as it supports greater hard coral and octocoral colony densities, and greater coral cover (Moyer et al. 2003; Gilliam et al. 2006; this study). Numerous factors may explain these differences between reefs: the recurrent tidal inlet discharge, recurrent groundwater seepage, recurrent freshwater inputs, and the high variability of substrate complexity and composition (Goldberg 1973). Gilliam et al. (2004) found that mean sedimentation rates at second reef sites (8.88 mg/cm^2*day) were significantly greater than at third reef sites (1.60 mg/cm^2*day); different sedimentation rates probably account for some of the differences in benthic population levels between second and third reefs. In this study, sessile benthic organisms of the second reef were consistently covered with fine sediments. Further, there was a noticeable daily increase in water column turbidity and sedimentation on the second reef coinciding with the outgoing tide, suggesting a chronic impact on biological communities caused by the recurrent exposure to inlet water and terrigenous runoff.

Griffin and Lipp (2009) and Reich et al. (2009) examined the hydrogeology and water quality bathing nearshore and offshore reefs of Broward County. Reich et al. (2009) found that the flow of inlet water transports more water, dissolved constituents, and particles onto the second and third reefs than groundwater seepage. Inlet discharge transports pollutants including bacteria (including fecal coliforms from animals and humans) and viruses (including enteroviruses) to the second and third reefs (Griffin and Lipp 2009). Water and coral samples collected from nearshore to offshore, showed a decrease in levels of bacteria and viruses with increasing distance from the Port Everglades inlet (Griffin and Lipp 2009). Hence, overall water quality may play an important role in influencing the biological community distribution near the OEC. Other factors that may influence the current population levels of sessile and motile organisms of the second and third reefs off Port Everglades include anchoring of large vessels, and recreational anchoring and fishing, During this study, there were numerous incidences of recreational vessels anchored on the first and second reefs while their boaters fished using hook and line or SCUBA. Large vessels anchored in the general area of the third reef but away from the existing OEC.

Comparisons of the results of this study with those of Moyer et al. (2003), Gilliam et al. (2006), and Gilliam (2007) corroborate in many cases the populations levels found here on the second and third reefs. Spatial variability of benthic communities across reefs (Edmunds and Bruno 1996; Hughes et al. 1999; Murdoch and Aronson 1999) may in part explain the differences between the results of this study and those of Moyer et al. (2003), Gilliam et al. (2006), and Gilliam (2007). Moyer et al. (2003), Gilliam et al. (2006), and Gilliam (2007) assessed biological communities in similar habitats of the second and third reefs, some 1.5 to 4.8 kilometers (km) away from Port Everglades (Figure 26). Moyer et al. (2003) data were collected across reefs and the relevant comparisons of "Corridor 3" and "Corridor 4" are discussed here. The Gilliam et al. (2006) and Gilliam (2007) data allow for more detailed comparisons of sites closer to the OEC with this study than those of Moyer et al. (2003). Gilliam et al. (2006) reported on the density and cover of scleractinans, and on the density for octocorals and sponges. They did not, however, report on other benthic components such as macroalgae, turf, or bare substratum; therefore comparisons of these components were not possible. Gilliam (2007) reported on the cover of all organisms, but did not report benthic organism densities. As a quick reference, Table 26 provides comparisons of coral cover and the density of organisms between this study and those of Gilliam et al. (2006), and Gilliam (2007).

Following are detailed comparisons of data between this study and those of Gilliam et al. (2006), and Gilliam (2007) and Moyer et al. (2003) by reef.

Table 26. Comparison of coral cover (%), and coral, octocoral, and sponge density at sites closest to Port Everglades. Reef 2 (second reef) and Reef 3 (third reef impact area) data are from this study; JUL 7, JUL8, FTL 2, FTL 3 data are taken from Gilliam et al. (2006); and BC2 and BC3 data are taken from Gilliam (2007).

	Second Reef				Third Reef			
	Reef 2 (R2)	**Jul 7**	**FTL 2**	**BC2**	**Reef 3 (R3)**	**Jul 8**	**FTL 3**	**BC3**
Depth (m)	12-18	10	15	12	14-19	15	18	17
Coral Cover (%)	0.4	1.1	1.0	0.4	1.0	1.4	0.8	0.5
Coral Density (colonies/m^2)	0.5	1.3	1.6	NA	1.8	2.0	1.7	NA
Octocorals (colonies/m^2)	0.34	0.4	9.0	NA	1.44	2.5	17	NA
Sponges (colonies/m^2)	0.12	7.2	8.4	NA	0.175	6.8	6.8	NA

4.1 Second Reef Comparisons

The Reef 2 site included hardbottom substrates interspersed by small and large areas of sand/shell hash and rubble. The substrate was covered by a thin veneer of fine-grained sediments, but within the site benthic cover was variable. In some areas, the hardbottom of Reef 2 was barren (e.g., R2-Z1, sampling point 2). In contrast, sponges were abundant in other areas of the Reef 2 hardbottom (e.g., R2-Z1, sampling point 3). Coral "health indicators" which included coral paling and bleaching, coral partial mortality caused by sedimentation, and algal overgrowth of coral colonies occurred at less than 12% of the scleractinians observed at Reef 2. However, when compared to other sites (Reef 3, R3-PI and R3-C) Reef 2 scleractinians had the highest occurrence of these health indicators. Due to the proximity to the inlet, water quality and visibility was highly variable at Reef 2 based on the daily tidal cycle.


Legend
Existing Channel
of Comparable Study
Scale: 1 inch = 1,000 meters
Drawn By: MR
DIAL CORDY
AND ASSOCIATES INC

The Reef 2 benthic communities examined here were similar to comparable second reef sites described in Moyer et al. (2003), Gilliam et al (2006), and Gilliam (2007) in terms of species and genus richness of scleractinians, octocorals, and sponges.

4.1.1 Hard Corals

The density of scleractinian colonies at Reef 2, 0.43 to 0.53 colonies/m^2, was lower compared to all but one zone on Reef 3 (R3-C-Z2). From 2000 to 2005, hard coral (including *M. alcicornis*) densities at all second reef sites ranged from 1.6 to 2.5 colonies/m^2 (Gilliam et al. 2006). At Gilliam et al.'s (2006) FTL2 site, coral density was 1.6 colonies/m^2 and 1.3 colonies/m^2 at JUL7 in 2005 (Gilliam et al. 2006) (Table 26). The greater coral density Gilliam et al. (2006) reported at FTL2 and JUL7 compared to R2 may be, in part, inflated by the inclusion of *M. alcicornis*. Yet, coral density remained greater at FTL2 and JUL7 compared to R2.

At the second reef in this study, mean hard coral cover (including *M. alcicornis*) was 0.37%. R2 and Gilliam's (2007) BC2 had similar coral cover values, while Gilliam et al.' (2006) JUL7 and FTL2 sites supported higher cover (Table 26). Species with highest cover at FTL2 were *M. meandrites* (0.32%), and *M. cavernosa* (0.18%), and at JUL7 were *M. cavernosa* (0.14%) and *S. siderea* (0.13%). *S. siderea* (0.14%) and *M. meandrites* had the highest cover at BC2 (Gilliam 2007). The most common coral encountered at R2 was *S. siderea* (Table 7).

Scleractinian corals of size Class I (0 to 3 cm) and Class II (4 to 10 cm) were the most common size classes at the second reef. There were less size Class I and size Class II corals at second reef site compared to third reef sites.

Total live cover at R2 was higher than what Moyer et al. (2003) found on the second reef within their Corridors 3 and 4 sites. This difference resulted from the category "turf algae" which was part of the live cover total in this study, and which was likely categorized as non-living substrate in Moyer et al. (2003). Note that Moyer et al. (2003) documented high macroalgae cover at Corridors 3 and 4, which was much higher than results for R2. The dominance of macroalgae in Corridors 3 and 4 may have been a seasonal artifact (Moyer et al. 2003). The octocoral, sponge, and scleractinian cover in R2 was lower than in Moyer et al.'s (2003) Corridors 3 and 4. Possible explanations for these discrepancies probably include natural spatial variability of benthic communities, distance from the inlet and the source of water quality impacts. Indeed, Moyer et al.'s (2003) Corridors 3 and 4 are more than 4.8 km away from the OEC (Figure 26).

4.1.2 Octocorals

Nine genera of octocorals were recorded on the second reef in this study. The octocoral densities at R2 were low and highly variable (R2-Z1 = 0.41 colonies/m^2 ± 0.40 *SD*; R2-Z2 = 0.26 colonies/m^2 ± 0.31 *SD*). In 2005, octocoral density at FTL2 was approximately 9 colonies/m^2, but was also highly variable (Gilliam et al. 2006). In contrast, octocoral density at JUL7 (0.43 colonies/ m^2) was very low and comparable to densities found in this study (Gilliam et al. 2006). Gilliam (2007) reported higher percent cover of octocorals (6.4%) at BC2 than results found in this study. Octocoral percent cover was low at R2 and also variable between zones (R2-Z1 = 1.56% ± 0.68 *SE*; R2-Z2 = 0.35% ± 0.13 *SE*). Most octocorals were less than 25 cm in height with the majority of individuals measuring 11 to 25 cm. There were, however, fewer size Class I and Class II individuals at Reef 2 compared to several third reef sites (R3, R3-PI, and R3-C).

4.1.3 Sponges, Zoanthids, and Algae

There were 17 sponge genera found at the Reef 2 study site. The barrel sponge *X. muta* was not observed within belt transects in R2-Z1, and few were observed in R2-Z2 (0.06 colonies/m^2 ± 0.13 *SD*). Sponge cover was higher in R2-Z2 when compared to R2-Z1 (3.35 ± 1.09 SE v. 1.89 ± 0.39 SE), both were lower when compared to sponge cover at BC 2 (5.05%) (Gilliam 2007). The boring sponge *Cliona* spp. was found in five of the 20 belt transects conducted at R2 (25% occurrence) in this study. There were few colonies of the zoanthid *P. caribaeorum* in R2 transects. Turf algae and the macroalga, *Dictyota*, were common at R2. There was 7% macroalgae at R2 versus 12% at BC2 (Gilliam 2007); the difference in cover may be related to seasonal differences in algae abundance. The benthic cyanobacteria *Lyngbya* was seen at R2-Z1.

4.1.4 Potential Impact Area

The surface area of the second reef in the path of the proposed OEC improvement amounts to 4.82 ha [11.9 acres (ac)]. Based on the mean total live cover found here at R2, approximately 56.2% of this area [or 2.7 ha (6.7 ac)] supports live cover including scleractinians (0.36%), hydrocorals (0.01%), octocorals (0.96%), sponges (2.62%), zonathids (0.01%), tunicates (0.08%), turf algae (45.19%), and macroalgae (6.99%). The dredging of this hardbottom area will potentially cause the removal of approximately 174 m^2 scleractinian cover, 5 m^2 hydrocoral cover, 463 m^2 octocoral cover, 1,263 m^2 sponge cover, 5 m^2 zoanthid cover, 21,782 m^2 turf algae cover, and 3,369 m^2 macroalgae cover. Based on colony density estimates at R2, up to approximately 25,546 scleractinian colonies, measuring mostly under 10 cm in diameter, will be removed. Note that 10 cm corresponds to approximately three years worth of lateral growth (Edmunds et al. 1998). Approximately 24,100 octocoral colonies measuring mostly less than 25 cm in height will also be removed.

4.2 Third Reef Comparisons

The R3 site (R3-Z1, Z2, and Z3) was located within the proposed OEC extension area (Figure 3). Site substrates at R3 consisted of hardbottom, rubble, rocks, pockets of coarse and fine sand, and few artificial substrates. Less than 3% of the scleractinians observed at R3 displayed some form of affliction. Species most affected were *S. siderea* and *S. intersepta*. Overall, the R3 site supported greater hard coral, octocoral, and sponge cover compared to R2.

With the exception of sponge density, hardbottom communities within R3 sampling locations were similar to at least one other third reef site of Broward County (e.g., octocoral and scleractinian density, scleractinian cover; Gilliam et al. 2006; Gilliam 2007, Table 26). The density of sponges at R3 was ten times less than what Gilliam et al. (2006) and Gilliam (2007) documented on other third reef sites. The *Lyngbya* bloom, which persisted from 2003 to 2005 (Paul et al. 2005), may have impacted sponges and octocorals more on the third reef off Port Everglades than in locations documented by Gilliam et al. (2006) and Gilliam (2007).

4.2.1 Hard Corals

The hard coral species richness within R3 (R3-Z1, Z2 and Z3) is similar to what Gilliam et al. (2006) found on the third reef and greater than what was documented in Gilliam (2007). Gilliam et al. (2006) encountered two species on the third reef, *D. labyrinthiformis* and *E. fastigiata*, that were not seen here. Conversely this study found four hard coral species not listed in Gilliam et al. (2006): *A. lamarcki*, *M. aliciae*, *M. ferox*, and *P. porites*. Table 27 displays the hard coral species found in this study, Gilliam et al. (2006), and Goldberg (1973).

The density of scleractinian colonies at R3 (R3-Z1, Z2, and Z3) ranged from 1.43 to 2.19 colonies/m^2. Gilliam et al. (2006) found that in 2003 coral colony density for all third reef sites averaged 2.8 coral colonies/m^2 (including *M. alcicornis*). At site FTL3, there were 1.7 coral colonies/m^2; and 2.03 coral colonies/m^2 at JUL8 (Gilliam et al. 2006).

The R3 hard coral cover (scleractinians and hydrocorals combined) ranged from 0.8 to1.21%. At FTL3, Gilliam et al. (2006) found a total of 0.78% hard coral cover (including *M. alcicornis*) and 1.4% hard coral cover at JUL8 (Table 26). Gilliam et al. (2006) found that species with highest cover were *S. intersepta* (0.25%), *M. cavernosa* (0.16%), and *M. meandrites* (0.12%) at FTL3 and *P. astreoides*, *S. intersepta* (0.4%), *M. cavernosa* (0.18%) at JUL8. Hard coral cover at BC3 was comparatively low (0.5%) (Gilliam 2007). Therefore, hard coral cover at R3 compared favorably with site JUL8 in Gilliam et al. (2006), but was somewhat higher than at FTL3 and BC3 (Table 26).

The majority of scleractinians documented here measured less than 10 cm in diameter. Most of the corals belonged to size Class II (4-10 cm). Between 8% and 19% of scleractinians at R3 had diameters ranging from 11 to 25 cm (size Class III), and less than 2% of the scleractinians were 26 to 50 cm (size Class IV) in diameter. No corals observed here measured more than 50 cm in diameter. Most of the *S. siderea*, *S. intersepta*, and *S. radians* colonies measured less than 10 cm across. In contrast with Goldberg (1973) who found *D. clivosa*, *M. annularis*, and *M. cavernosa* with diameters exceeding 30 cm, very few scleractinian colonies had diameters exceeding 25 cm, even among the *M. cavernosa* colonies. Very few *M. alcicornis* colonies were observed on the third reef duing this study;.density estimates of *M. alcicornis* were less than 0.30 colonies/m^2 and associated with high variability.

The R3 total live cover values were higher here than those found at third reef sites within Corridor 3 and 4 in Moyer et al. (2003). This was due to the category "turf algae" added here and which was part of non-living substrate in Moyer et al. (2003). Interstingly, Moyer et al. (2003) documented substantially higher macroalgae cover at Corridors 3 and 4 on the third reef compared to what was found here. This difference in macroalgae cover was probably a seasonal artifact (Moyer et al. 2003). The octocoral, sponge, and scleractinian cover in R3 was lower than in Moyer et al.'s (2003) Corridors 3 and 4. Possible explanations for these discrepancies probably include natural spatial variability of benthic communities, distance from the inlet and the source of water quality impacts. Indeed, Moyer et al.'s (2003) Corridors 3 and 4 are more than 4.8 km away from the OEC (Figure 26).

Table 27. List of scleractinian species found on the third reef as reported in Goldberg (1973) off Boca Raton, Gilliam et al. (2006) off Broward County, and this study

Species	Goldberg (1973)	Gilliam et al. (2006)	This Study (2006)
Acropora cervicornis	x		
Agaricia agaricites	x	x	x
Agaricia lamarcki			x
Colpophyllia natans	x		
Dichocoenia stokesii	x	x	x
Diploria clivosa	x		
Diploria labyrinthiformis	x	x	
Diploria strigosa		x	x
Eusmilia fastigiata	x	x	
Madracis decactis	x	x	x
Manicina areolata	x		
Meandrina meandrites	x	x	x
Montastraea annularis	x	x	x
Montastraea cavernosa	x	x	x
Mussa angulosa	x		
Mycetophyllia aliciae			x
Mycetophyllia ferox			x
Mycetophyllia lamarckiana	x		
Phyllangia Americana	x		
Porites astreoides	x	x	x
Porites porites			x
Scolymia spp.		x	x
Siderastrea radians		x	x
Siderastrea siderea	x	x	x
Solenastrea bournoni		x	x
Solenastrea hyades	x		
Stephanocoenia intersepta	x	x	x
Total	19	15	18

4.2.2 Octocorals

Goldberg (1973) found that octocorals were the most abundant benthic organisms on the third reef; he counted 10 genera and 19 species of octocorals (Table 28). In this study, 12 octocoral genera were found within third reef sites (Reef 3, R3-PI, and R3-C) (Table 28). Compared with Goldberg (1973), only two genera were not found on the third reef: *Gorgonia* and *Nicella*. Up to nine octocoral genera were found here in R3.

Table 28. List of octocoral genera found on the third reef (Reef 3, R3-PI, R3-C) in this study and as reported in Goldberg (1973) off Boca Raton.

Genera	Goldberg (1973)	This Study (2006)
Briareum	X	x
Ellisella	X	x
Erythropodium		x
Eunicea	x	x
Gorgonia	x	
Iciligorgia	x	x
Muricea	x	x
Muriceopsis		x
Nicella	X	
Plexaura	X	x
Plexaurella	X	x
Pseudoplexaura		x
Pseudopterogorgia	X	x
Pterogorgia		x
Total	10	12

Octocoral density at Gilliam et al.'s (2006) study sites was highly variable: density at the FTL3 site was approximately 17 colonies/m^2 and 2.5 colonies/m^2 at JUL8. In this study, octocoral density within the third reef sites ranged from 0.09 to 1.68 colonies/m^2. While octocoral density estimates were highly variable in this study, the range of density was substantially smaller than what Gilliam et al. (2006) recorded. Percent cover of octocorals ranged from 0.18 to 3.5% across third reef sites. The cover estimates were low compared to the 14% octocoral cover Gilliam (2007) found at site BC3. Overall, the third reef sites in this study were less populated with octocorals than those assessed by Gilliam et al. (2006) and Gilliam (2007). An overall decline in octocoral density in Broward County since 2003 has been linked to a Lyngbya bloom (Gilliam and Dodge 2006); this alone does not explain the differences in octocoral density and cover found between the third reef sites reported here and the FTL3 and BC3 sites.

More than 74% of octocorals at third reef sites (Reef 3, R3-PI, and R3-C) were less than 25 cm in height (includes size Class I and II colonies). Goldberg (1973) found that some octocorals of the third reef off Boca Raton, including *Plexaurella fusifera* and *Eunicea tourneforti*, measured 80 cm in height (the equivalent of size Class IV in this report, i.e., > 50 cm) and were larger compared to counterparts in shallower parts of the second reef. In this study, less than 4% of octocoral colonies measured more than 50 cm in height.

4.2.3 Sponges, Zoanthids, and Algae

During this study, the third reef contained 20 genera of sponges. Goldberg (1973) found that the barrel sponge, *X. muta,* was a common occurrence on the third reef off Boca Raton. Goldberg (1973) also found in places large encrusting sheets of the zoanthid *Palythoa* sp. *Dictyota* was then the most common alga on the third reef (Goldberg 1973). In this study, the Third reef sites

(Reef 3, R3-PI, and R3-C) contained the highest density of barrel sponges compared to all other sites (0.175 colonies/m^2). The majority of *X. muta* colonies in the R3 site (62 out of 84 colonies) were less than 25 cm in height (Size Class I). There were fewer colonies measuring 16 to 50 cm in height (Class II; 21 colonies) and even fewer colonies measuring more than 50 cm in height (Class III; 1 colony). Sponge density values are not comparable across studies because this study only considered *X. muta* measurements in density calculation due to the low occurrence of sponges overall. R3 contained the highest abundance of the zoanthid, *P. caribeorum*, compared to the other sites on the second and third reefs. Turf algae and the macroalga, *Dictyota*, were common at R3. The benthic cyanobacteria *Schizothrix* was seen at R3-Z3.

4.3 Conclusion

The second reef supported benthic communities were less developed than those on the third reef. The second reef sampling site R2 (R2-Z1 and R2-Z2) was depauperate and had high sediment cover compared to R3 (R3-Z1, R3-Z2, and R3-Z3). Moyer et al. (2003) and Gilliam et al. (2006) show that second and third reef benthic communities are typically different. Third reef sites are more developed biologically as they support greater hard coral colony densities, coral cover, and octocoral colony densities (e.g., Gilliam et al. 2006). The analysis of the data collected for this study corroborated Gilliam et al.'s (2006) assessments of the differences between second and third reef benthic communities. The relative proximity to the Port Everglades inlet and associated water quality degradation Griffin and Lipp (2009) may explain in part why biological populations of the second and third reefs are somewhat more developed away from the inlet as shown in Moyer et al. (2003), Gilliam et al. (2006) and Gilliam (2007) compared to what was found in this study.

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APPENDICES

APPENDIX A

Visual Assessment Data

C-Z1	RP1																			
Transect	**T1**					**T2**					**T3**					**T4**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa									1											
E. fastigiata																				
L. cucullata																				
M. annularis																				
M. cavernosa			1			1	1	1	1					1			2			
M. decactis																	1			
M. ferox																				
M. meandrites																				
P. astreoides		2					2					3					5			
P. porites																				
S. bournoni																				
S. intersepta						1	2		1			4								
S. siderea		2	1				1	1				1								
S.radians						1	2										3			
Hydrocoral species																				
M. alcicornis	1					1														
M. complanata																	4			

C-Z1	RP2																			
Transect	**T5**					**T6**					**T7**					**T8**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites		1																		
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis																				
M. cavernosa		3					2	1			1	2	1			2	4	1		
M. decactis							1									1	1			
M. ferox																				
M. meandrites							1													
P. astreoides		2				1	1					3	1				3			
P. porites																	2			
S. bournoni																				
S. intersepta		1					1				1	2				1				
S. siderea							1				2	3					2	1		
S.radians											2	1								
Hydrocoral species																				
M. alcicornis	1	4					1					3				1			1	
M. complanata																				

C-Z1	RP3																			
Transect	**T9**					**T10**					**T11**					**T12**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites								1												
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii							1									2	1			
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis		1																		
M. cavernosa		2					2									2	3			
M. decactis							1										3			
M. ferox																				
M. meandrites																	1			
P. astreoides		6				2	5	1									6	1		
P. porites																				
S. bournoni																		1		
S. intersepta	1	3	1			2					1					1	3			
S. siderea	2	5					3				1	2				1	2			
S.radians		1																		
Hydrocoral species																				
M. alcicornis		4					1				1						1			
M. complanata																				

C-Z1	RP4																			
Transect	**T13**					**T14**					**T15**					**T16**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites																				
C. natans								1												
D. clivosa																				
D. labyrinthiformis																				
D. stokesii		1																		
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis	1																			
M. cavernosa		2	3																	
M. decactis																				
M. ferox																			1	
M. meandrites																				
P. astreoides		6		1			1	2				3								
P. porites																	4			
S. bournoni								1												
S. intersepta	1						2				1									
S. siderea						1					1	3					1	1		
S.radians																				
Hydrocoral species																				
M. alcicornis		1										2					1			
M. complanata																				

C-Z2	RP1										RP2																			
Transect	T1					T3					T5					T6					T7					T8				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																														
A. agaricites																														
A. agaricites																														
C. natans																														
D. clivosa																														
D. labyrinthiformis																														
D. stokesii																														
D. strigosa																														
E. fastigiata																														
L. cucullata																														
M. annularis		2					1																							
M. cavernosa							1	1				1		1									1			1				
M. decactis																											1			
M. ferox																														
M. meandrites																														
P. astreoides		2										3					3					1	1				4	1		
P. porites																	2					2								
S. bournoni																												1		
S. intersepta						3	1									1	1					3								
S. siderea						1					1	2				1	1	1			6	5	1				4			
S.radians																						1				1				
Hydrocoral species																														
M. alcicornis																		1									1			
M. complanata																														

C-Z2	RP3																				RP4																			
Transect	T9					T10					T11					T12					T13					T14					T15					T16				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																																								
A. agaricites																			1														2							
A. agaricites																																	2							
C. natans																																								
D. clivosa																																								
D. labyrinthiformis																																								
D. stokesii																																	1							
D. strigosa																																								
E. fastigiata								1																																
L. cucullata																																								
M. annularis													1																											
M. cavernosa			3				1						2	1				1				1					1					1								
M. decactis																											1													
M. ferox																																								
M. meandrites																																					1			
P. astreoides							1						1										1				1									1				
P. porites			1			1	1				1																					1						1		
S. bournoni						1											1																							
S. intersepta		1				1	2	1			1					2					2							1			2	1					3			
S. siderea		1				2		1								4						2					3										1			
S.radians						1						1										1																		
Hydrocoral species																																								
M. alcicornis												4		1													1					1								
M. complanata																																								

C-Z3	RP1																			
Transect	T1					T2					T3					T4				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii							1													
D. strigosa																				
E. fastigiata							1									1				
L. cucullata																				
M. annularis																				
M. cavernosa	1	3				1	1	1								1				
M. decactis																				
M. ferox																				
M. meandrites																				
P. astreoides	1	3				1	1	1					1			2	2			
P. porites	5	6						1												
S. bournoni																				
S. intersepta	2	5				3	6					3				3	3			
S. siderea	4	1				3	3									1	1			
S.radians								1								1				
Hydrocoral species																				
M. alcicornis																				
M. complanata																				

C-Z3	RP2																			
Transect	T5					T6					T7					T8				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																2	1			
D. strigosa																				
E. fastigiata																				
L. cucullata		1																		
M. annularis	1			1		2	2	1												
M. cavernosa	1	2	1			1	2	1				1	1					1		
M. decactis																				
M. ferox																				
M. meandrites																	1			
P. astreoides		6					1				1	5	1					1		
P. porites																				
S. bournoni			1				1													
S. intersepta	4	5					2				1	3	1			5	3			
S. siderea	3	4					1				3	3				1				
S.radians	1	2									1						1			
Hydrocoral species																				
M. alcicornis	2						1					1						1		
M. complanata																				

C-Z3	RP3														
Transect	T9					T10					T12				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species															
A. agaricites											1				
C. natans															
D. clivosa															
D. labyrinthiformis															
D. stokesii															
D. strigosa															
E. fastigiata															
L. cucullata															
M. annularis															
M. cavernosa											1	1	3	1	
M. decactis															
M. ferox															
M. meandrites													1		
P. astreoides						1							1		
P. porites															
S. bournoni															
S. intersepta		1													
S. siderea	3	2										2			
S.radians															
Hydrocoral species															
M. alcicornis			2				1				2	4			
M. complanata															

C-Z3	RP4														
Transect	T13					T14					T15				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species															
A. agaricites		2					1								
C. natans															
D. clivosa															
D. labyrinthiformis															
D. stokesii								1							
D. strigosa															
E. fastigiata															
L. cucullata															
M. annularis															
M. cavernosa		2											1		
M. decactis			1				1	2			1				
M. ferox															
M. meandrites															
P. astreoides			2									1			
P. porites															
S. bournoni															
S. intersepta	1						1								
S. siderea		3										1			
S.radians		1													
Hydrocoral species															
M. alcicornis			1												
M. complanata															

R2-Z1	RP1																				RP2															RP3															RP4																			
Transect	T1					T2					T3					T4					T5					T6					T8					T9					T11					T12					T13					T14					T15					T16				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																																																																						
A. agaricites		1																																																																				
C. natans																																																																						
D. clivosa																																																																						
D. labyrinthiformis																																																																						
D. stokesii																																																				1																		
D. strigosa													1																																																		1							
E. fastigiata																																																																						
L. cucullata																																																																						
M. annularis		1																																																											2	2								
M. cavernosa							1						1																													1					1		1								1											1		
M. decactis																												1																																										
M. ferox																																																																						
M. meandrites							1	1																																								1																						
P. astreoides																	1																														1															1								
P. porites																																																																						
S. bournoni																																																																						
S. intersepta	1	1																														1																													2	5								
S. siderea		1	1									1										1					1										2	1													3	1									8	1								
S.radians																																																													3	3								
Hydrocoral species																																																																						
M. alcicornis		1	1				2					1																																																											
M. complanata																																																																						

R2-Z2	RP1																			
Transect	T1					T2					T3					T4				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis								1				1	1					1		
M. cavernosa												1	1							
M. decactis																				
M. ferox																				
M. meandrites																		1		
P. astreoides																				
P. porites																				
S. bournoni																				
S. intersepta											1	2					3			
S. siderea											3	2				1				
S.radians																				
Hydrocoral species																				
M. alcicornis												1								
M. complanata																				

R2-Z2	RP2																			
Transect	T5					T6					T7					T8				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis																	1	1		
M. cavernosa																	1	3		
M. decactis																				
M. ferox																				
M. meandrites																				
P. astreoides							1													
P. porites																				
S. bournoni																				
S. intersepta						1												1		
S. siderea																				
S.radians																				
Hydrocoral species																				
M. alcicornis																				
M. complanata																				

R2-Z2	RP3																			
Transect	T9					T10					T11					T12				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa																				
E. fastigiata																	1			
L. cucullata																				
M. annularis																				
M. cavernosa		1														1				
M. decactis																	4			
M. ferox																				
M. meandrites																				
P. astreoides																	1			
P. porites																				
S. bournoni																				
S. intersepta																1	1			
S. siderea		1	1													1	1			
S.radians												1				1	1			
Hydrocoral species																				
M. alcicornis																				
M. complanata																				

R2-Z2	RP4																			
Transect	T13					T14					T15					T16				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans				1																
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis																	1			
M. cavernosa												2					1			
M. decactis																				
M. ferox																				
M. meandrites												1								
P. astreoides		1										1	1				3			
P. porites																				
S. bournoni																				
S. intersepta	5	1					3				1	2	1				3			
S. siderea	2	2									1	1					3			
S.radians	1																1			
Hydrocoral species																				
M. alcicornis																				
M. complanata																				

R3-Z1	RP1																			
Transect	T1					T2					T3					T4				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis																				
M. cavernosa		1	1				5	3			2	2	1				2	1		
M. decactis												1								
M. ferox																				
M. meandrites							1	2				2				1				
P. astreoides		4					1				1	5					4			
P. porites			1																	
S. bournoni																				
S. intersepta	1	2					1					3				1	1			
S. siderea	1	4									2	2					2			
S.radians		2					1					1					1			
Scolymia																				
Hydrocoral species																				
M. alcicornis	2	2	1	2			2	2			1	3						2		
M. complanata																				

R3-Z1	RP2														
Transect	T5					T6					T7				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species															
A. agaricites															
C. natans															
D. clivosa															
D. labyrinthiformis															
D. stokesii							1								
D. strigosa															
E. fastigiata															
L. cucullata															
M. annularis															
M. cavernosa			2			1	1	3			2				
M. decactis						1									
M. ferox															
M. meandrites															
P. astreoides	1	2	2				10	1				1			
P. porites		1													
S. bournoni															
S. intersepta	1					1					1	1			
S. siderea	2					2	1				8	1			
S.radians			1									1			
Scolymia	1														
Hydrocoral species															
M. alcicornis							2	2	1						
M. complanata															

R3-Z1	RP3																			
Transect	T9					T10					T11					T12				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites		1						1												
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii	2										1									
D. strigosa																		1		
E. fastigiata																				
L. cucullata																				
M. annularis	1																			
M. cavernosa								1			1						5	2		
M. decactis			1									1								
M. ferox																				
M. meandrites																				
P. astreoides	2	5	3			1	3	1				4				1	8	3		
P. porites												1								
S. bournoni																				
S. intersepta	2	2				1	6				5					5	1			
S. siderea	8	3				4	3				5	3				3	2	1		
S.radians	2	2				1					4	3				1	2			
Scolymia																				
Hydrocoral species																				
M. alcicornis	3	4	1								1	4	1				1			
M. complanata																				

R3-Z1	RP4																			
Transect	T13					T14					T15					T16				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites		1														1				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa																		1		
E. fastigiata																				
L. cucullata																				
M. annularis		1																		
M. cavernosa		1	1			3	3				1	3				2	3	1		
M. decactis	1																			
M. ferox																				
M. meandrites																1				
P. astreoides	2	3				1	3	1				4	1				4	1		
P. porites												1					1			
S. bournoni																				
S. intersepta	4	2				4	1					1				8	3			
S. siderea	2	1				3	5				1	2				3	1			
S.radians	2	1									3	1								
Scolymia																				
Hydrocoral species																				
M. alcicornis	1	1					2										1			
M. complanata																				

R3-Z2	RP1																			
Transect	T1					T2					T3					T4				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii											1	1								
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. aliciae									1									1		
M. annularis																				
M. cavernosa		3				1		1			1					1				
M. decactis												2						1		
M. ferox																				
M. meandrites	1															1				
P. astreoides		2					1					1					1			
P. porites																				
S. bournoni																				
S. intersepta	3	1				1	4				4	2	1			1	4			
S. siderea	4	1	1				2	1				2								
S.radians						1	1										1			
Scolymia																				
Hydrocoral species																				
M. alcicornis		2					1				1		1							
M. complanata																				

R3-Z2	RP2																			
Transect	T5					T6					T7					T8				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii											3									
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. aliciae																				
M. annularis																				
M. cavernosa			1				2				1									
M. decactis												2	1							
M. ferox																				
M. meandrites							2													
P. astreoides							1										2			
P. porites																				
S. bournoni																				
S. intersepta	1	3				3	3				3	2	1			3	2			
S. siderea	6	2	1				2				4	2	1				2			
S.radians						1	2					2				1				
Scolymia																1				
Hydrocoral species																				
M. alcicornis	1																1			
M. complanata																				

R3-Z2	RP3																			
Transect	T9					T10					T11					T12				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii						1	1													
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. aliciae																				
M. annularis																				
M. cavernosa						2	1					1					2			
M. decactis												1								
M. ferox																				
M. meandrites												1								
P. astreoides		1										1				1	4			
P. porites		1																		
S. bournoni																				
S. intersepta	1	4					3				1	3				2	4	1		
S. siderea	1	2				3	2	1			4	3				4				
S.radians		1				1					1					1		1		
Scolymia																				
Hydrocoral species																				
M. alcicornis	2	4	4	1							1	3								
M. complanata																				

R3-Z2	RP4														
Transect	T13					T14					T16				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species															
A. agaricites								1							
C. natans															
D. clivosa															
D. labyrinthiformis															
D. stokesii							1								
D. strigosa															
E. fastigiata															
L. cucullata															
M. aliciae															
M. annularis															
M. cavernosa						1					1	4			
M. decactis			1										1		
M. ferox															
M. meandrites												1			
P. astreoides							2				1	2			
P. porites															
S. bournoni															
S. intersepta						1	1				5				
S. siderea						2					1	3			
S.radians											1	3			
Scolymia															
Hydrocoral species															
M. alcicornis	1	3					1					4	1		
M. complanata															

R3-Z3	RP1																			
Transect	**T1**					**T2**					**T3**					**T4**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites																				
A. lamarki																		1		
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii							1					1								
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis			1										1					1		
M. cavernosa	1					4	3	1				1					2	1		
M. decactis	1	2	1				1										1			
M. ferox																				
M. meandrites							1						1				2			
P. astreoides			1					1				5	2					2	1	
P. porites	1							2												
S. bournoni													1							
S. intersepta	3	3				2	10				4	3	2	1		3	5	4		
S. siderea	2	4				5	5	1			2	4				1	4			
S.radians		1				1	3										1	1		
Scolymia. spp.																1				
Hydrocoral species																				
M. alcicornis			1				1	1				3	1					1		
M. complanata																				

R3-Z3	RP2														
Transect	**T5**					**T6**					**T7**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species															
A. agaricites		1													
A. lamarki															
C. natans															
D. clivosa															
D. labyrinthiformis															
D. stokesii															
D. strigosa				1											
E. fastigiata															
L. cucullata															
M. annularis															
M. cavernosa		1	1								1		1		
M. decactis			1												
M. ferox															
M. meandrites			1				1								
P. astreoides			5						1			4	2		
P. porites															
S. bournoni															
S. intersepta	2	1				1	2					5			
S. siderea	3	3	2				1								
S.radians															
Scolymia. spp.															
Hydrocoral species															
M. alcicornis		1						1	1			5	2		
M. complanata															

R3-Z3	RP3														
Transect	**T9**					**T10**					**T11**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species															
A. agaricites															
A. lamarki															
C. natans															
D. clivosa															
D. labyrinthiformis															
D. stokesii															
D. strigosa															
E. fastigiata															
L. cucullata															
M. annularis												1	1		
M. cavernosa			1				1					1			
M. decactis			1								1				
M. ferox															
M. meandrites															
P. astreoides		5	2				1								
P. porites		1													
S. bournoni															
S. intersepta	2	1										1			
S. siderea	3	3					2								
S.radians						1	1								
Scolymia. spp.															
Hydrocoral species															
M. alcicornis												2	1		
M. complanata															

R3-Z3	RP4														
Transect	**T13**					**T15**					**T16**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species															
A. agaricites		2	2								1	2			
A. lamarki															
C. natans															
D. clivosa															
D. labyrinthiformis															
D. stokesii															
D. strigosa															
E. fastigiata															
L. cucullata															
M. annularis															
M. cavernosa	2	2				2					1	1			
M. decactis			1									1			
M. ferox		1													
M. meandrites												1			
P. astreoides		4	1			1	4	2				5			
P. porites															
S. bournoni															
S. intersepta		3				1	1					3			
S. siderea	3	2				3	5				2	5	1		
S.radians		1				1	1				1				
Scolymia. spp.															
Hydrocoral species															
M. alcicornis								1	1		1	2	2		
M. complanata															

RI-Z1	RP1																			
Transect	**T1**					**T2**					**T3**					**T4**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis							1													
M. cavernosa		1				1												1		
M. decactis												1					1	1		
M. ferox																				
M. meandrites							2													
P. astreoides	2	1					2	1				3	1				5			
P. porites	5																			
S. bournoni																				
S. intersepta	2					1	2				1	2				1	1			
S. siderea	4	12				4	4				4	2				1	6	1		
S.radians							1				2									
Hydrocoral species																				
M. alcicornis	1	2									1						2	2		
M. complanata																				

RI-Z1	RP2																			
Transect	**T5**					**T6**					**T7**					**T8**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites																				
C. natans																				
D. clivosa																				
D. labyrinthiformis		1																		
D. stokesii																				
D. strigosa												1								
E. fastigiata																				
L. cucullata																				
M. annularis																				
M. cavernosa	2		1									1								
M. decactis						1						1								
M. ferox																	1			
M. meandrites																				
P. astreoides	1	7	1				3	1				7					5	2		
P. porites							1										1			
S. bournoni																				
S. intersepta	3	5									11	6				1				
S. siderea	5	5					4				4	5				5	6			
S.radians	1	3				1					2					3	1			
Hydrocoral species																				
M. alcicornis	2		1			1	1					1				2				
M. complanata																				

RI-Z1	RP3																			
Transect	**T9**					**T10**					**T11**					**T12**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites	1																			
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii						1						1								
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis	2															1				
M. cavernosa	4	3				1	2				3	1								
M. decactis		1						1								1				
M. ferox																				
M. meandrites																				
P. astreoides	2	5	1				6	1				1				1	2			
P. porites		1																		
S. bournoni																				
S. intersepta	3					3	1					1				4	3			
S. siderea	3	3				5	4	1			3	7				6	2			
S.radians						1														
Hydrocoral species																				
M. alcicornis		2				1	6	1												
M. complanata																				

RI-Z2	RP1																			
Transect	**T1**					**T2**					**T3**					**T4**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites		1																		
A.fragilis								1												
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii		2																		
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis			1																1	
M. areolata																				
M. cavernosa	1	3					2	1			1							3		
M. decactis		2									1	1	1				1			
M. ferox																				
M. meandrites																				
P. astreoides							1					3				1	1			
P. porites												1								
S. bournoni			1																	
S. intersepta	2					1	1				2					2	6			
S. siderea	1		1								1	3				3				
S.radians	1					1						1				1				
Scolymia						1														
Hydrocoral species																				
M. alcicornis		4	2					1										1		
M. complanata																				

RI-Z2	RP2																			
Transect	**T5**					**T6**					**T7**					**T8**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites																				
A.fragilis																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii												1								
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis																				
M. areolata																				
M. cavernosa	2	2	1				2						1				1	1		
M. decactis		1	1			1	1													
M. ferox																				
M. meandrites						1	2													
P. astreoides		2					3	1									1			
P. porites							1													
S. bournoni																				
S. intersepta	3	1				3	4				2	2				2	5			
S. siderea						3	1				1						1			
S.radians	3					2	2					1				1				
Scolymia																				
Hydrocoral species																				
M. alcicornis																				
M. complanata																				

RI-Z2	RP3																			
Transect	**T9**					**T10**					**T11**					**T12**				
Size class	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Scleractinian species																				
A. agaricites																				
A.fragilis																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii	1																2			
D. strigosa																				
E. fastigiata																				
L. cucullata																				
M. annularis		1	2																	
M. areolata																1				
M. cavernosa		1						1				1								
M. decactis											1									
M. ferox																				
M. meandrites																				
P. astreoides		1					1											1		
P. porites																				
S. bournoni																				
S. intersepta		2					1	1			1	5				1	1			
S. siderea	2	3				4	3				3	2				3	3			
S.radians		1														1				
Scolymia																				
Hydrocoral species																				
M. alcicornis							1					1								
M. complanata																				

RI-Z3	RP1																			
Transect	T1					T2					T3					T4				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites												1								
A. fragilis																				
A.humilis																				
C. natans																				
D. clivosa																				
D. labyrinthiformis							1													
D. stokesii																	1			
D. strigosa																				
E. fastigiata																				
F. fragum																				
L. cucullata																				
M. annularis							1	3												
M. areolata																				
M. cavernosa	1																			
M. decactis											1									
M. ferox																				
M. meandrites											1									
P. astreoides							3					6					1			
P. porites																				
S. bournoni																				
S. intersepta	1	1					4				1	1				1				
S. siderea	1	3					1				6	3								
S.radians							1				1	4				1	1			
Hydrocoral species																				
M. alcicornis							4				1	1								
M. complanata																				

RI-Z3	RP2																			
Transect	T5					T6					T7					T8				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
A. fragilis																				
A.humilis																				
C. natans				1																
D. clivosa																				
D. labyrinthiformis																				
D. stokesii		1	1														2			
D. strigosa				1															1	
E. fastigiata																				
F. fragum																				
L. cucullata																				
M. annularis																	1	1		
M. areolata																				
M. cavernosa	4	1	2			1					1						2	3	1	
M. decactis											1	1								
M. ferox																				
M. meandrites		1															1			
P. astreoides		1	1				3				1	1					3			
P. porites																				
S. bournoni																				
S. intersepta	1	8	1			2	2				1	2				1	7			
S. siderea	3					1	3				2	1					1	1		
S.radians		1				1											1			
Hydrocoral species																				
M. alcicornis	3		1														1	2	1	
M. complanata																				

RI-Z3	RP3																			
Transect	T9					T10					T11					T12				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites		1																		
A. fragilis																				
A.humilis																	1			
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii												1								
D. strigosa																				
E. fastigiata							1													
F. fragum							1													
L. cucullata																				
M. annularis			1			1														
M. areolata							1													
M. cavernosa	1	2	2				3						1							
M. decactis		1											1			1		1		
M. ferox																				
M. meandrites																				
P. astreoides		4				1	5						1				1	1		
P. porites																				
S. bournoni																				
S. intersepta	1	1				1	3				2	5								
S. siderea	1	1	1			6	4				4	2	1			4	6	1		
S.radians	1	1					1					2				1				
Hydrocoral species																				
M. alcicornis		1	1			1	3	1			1		1							
M. complanata																				

RI-Z3	RP4																			
Transect	T13					T14					T15					T16				
Size class	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Scleractinian species																				
A. agaricites																				
A. fragilis																				
A.humilis																				
C. natans																				
D. clivosa																				
D. labyrinthiformis																				
D. stokesii																				
D. strigosa																				
E. fastigiata																				
F. fragum																				
L. cucullata																				
M. annularis																				
M. areolata																				
M. cavernosa																				
M. decactis																				
M. ferox																				
M. meandrites																				
P. astreoides																				
P. porites																				
S. bournoni																				
S. intersepta																				
S. siderea																				
S.radians																				
Hydrocoral species																				
M. alcicornis																				
M. complanata																				

C-Z1	RP1																			
Octocoral genus	T1					T2					T3					T4				
Size class	1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4	
Briareum	1		1								1						1			
Ellisella																1				
Erythropodium																				
Eunicea	1																			
Iciligorgia																				
Muricea		1																		
Muriceopsis																				
Plexaura																	1			
Plexaurella																				
Pseudoplexaura																	1			
Pseudopterogorgia	4	1	3	1		1	3				1	2								
Pterogorgia											2	1				2	2	1		

C-Z1	RP2															
Octocoral genus	T5				T6				T7				T8			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum	1				1	4								2		
Ellisella																
Erythropodium																
Eunicea						1		1		1						
Iciligorgia														1		
Muricea																
Muriceopsis																
Plexaura					1	1			1							
Plexaurella																
Pseudoplexaura					1											
Pseudopterogorgia			2						5	4	2			2		
Pterogorgia					1	3			1				7	2	1	

C-Z1	RP3															
Octocoral genus	T9				T10				T11				T12			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum					2		1		1				2	1		
Ellisella																
Erythropodium																
Eunicea																
Iciligorgia																
Muricea						1										
Muriceopsis																
Plexaura			1		1											
Plexaurella																
Pseudoplexaura																
Pseudopterogorgia	1	5	4		1				1	3						
Pterogorgia	1				9	6	1						5	6	1	

C-Z1	RP4															
Octocoral genus	T13				T14				T15				T16			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum	1	2	1	1	2					2			4			
Ellisella																
Erythropodium																
Eunicea													1	1		
Iciligorgia																
Muricea						1	2									
Muriceopsis																
Plexaura													1	1	2	
Plexaurella																
Pseudoplexaura																
Pseudopterogorgia		4								4	3					
Pterogorgia					5	4	1						8	1	3	2

C-Z2	RP1								RP2																RP3																RP4															
Octocoral genus	**T1**				**T3**				**T5**				**T6**				**T7**				**T8**				**T9**				**T10**				**T11**				**T12**				**T13**				**T14**				**T15**				**T16**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum					2	1																1			7	5	2		1	2			7		1											2			5	2	1		1			
Ellisella																																																								
Erythropodium																																																								
Eunicea																													1	1		1					1				1	1				3	1	1	1					3		
Iciligorgia																																																								
Muricea																																																	5	3						
Muriceopsis																																																								
Plexaura																																	1													2	1						1			
Plexaurella																																																								
Pseudoplexaura																																											1								1		2	1		
Pseudopterogorgia																		1			1	1												2	3	1	1					1	1						1	3	1	1				
Pterogorgia										1			2																1	3							2		2						1	2									1	

C-Z3	RP1																RP2																RP3												RP4											
Octocoral genus	**T1**				**T2**				**T3**				**T4**				**T5**				**T6**				**T7**				**T8**				**T9**				**T10**				**T12**				**T13**				**T14**				**T15**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum							1																						1		1		3	1							1	1				3								1	1	
Ellisella																																																								
Erythropodium																	1																1	8	1							1			1				2	2	1			1		
Eunicea																																						2			1				1					1						
Iciligorgia																																																								
Muricea																																																								
Muriceopsis																																																								
Plexaura																																		1								1				3	2		3	1	2			3		
Plexaurella								2																																								1								
Pseudoplexaura																																			1												1									
Pseudopterogorgia		1															1																1	2	3			2			3	3	2		1	4				1			1	5	3	
Pterogorgia																																																								

R2-Z1	RP1																RP2												RP3												RP4															
Octocoral genus	T1				T2				T3				T4				T5				T6				T8				T9				T11				T12				T13				T14				T15				T16			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum	1					1							1	1																3	2		1				3	3	1						1	1	1									
Ellisella																																																								
Erythropodium																																																								
Eunicea			1																											1																										
Iciligorgia																																																								
Muricea											1																				1																									
Muriceopsis																																																								
Plexaura		2				5			1	1				1																												1														
Plexaurella																																																								
Pseudoplexaura																																																					1			
Pseudopterogorgia		1	1	2		2					2	4		2	1														1	2				2			1																			
Pterogorgia			1																																																					

R2-Z2	RP1															
Octocoral genus	T1				T2				T3				T4			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum																
Ellisella																
Erythropodium																
Eunicea																
Gorgonia														1		
Iciligorgia																
Muricea																
Muriceopsis																
Plexaura																
Plexaurella																
Pseudoplexaura																
Pseudopterogorgia																
Pterogorgia																

R2-Z2	RP2															
Octocoral genus	T5				T6				T7				T8			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum																
Ellisella																
Erythropodium																
Eunicea										3						
Gorgonia																
Iciligorgia																
Muricea																
Muriceopsis																
Plexaura							1							2		
Plexaurella																
Pseudoplexaura																
Pseudopterogorgia																
Pterogorgia																

R2-Z2	RP3															
Octocoral genus	T9				T10				T11				T12			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum									3					2	1	
Ellisella																
Erythropodium																
Eunicea												1				
Gorgonia																
Iciligorgia																
Muricea											1					
Muriceopsis																
Plexaura																
Plexaurella										1						
Pseudoplexaura																
Pseudopterogorgia									1	1						
Pterogorgia																

R2-Z2	RP4															
Octocoral genus	T13				T14				T15				T16			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum		1				1			4		1		1	3		
Ellisella																
Erythropodium																
Eunicea		1														
Gorgonia																
Iciligorgia																
Muricea															1	
Muriceopsis																
Plexaura			1		1					1					2	
Plexaurella																
Pseudoplexaura															1	
Pseudopterogorgia		2								1			1			
Pterogorgia																

R3-Z1	RP1																RP2											
Octocoral genus	**T1**				**T2**				**T3**				**T4**				**T5**				**T6**				**T7**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum	1	1	1		1	2	2		7	4			5	1			6	6	2		3	4						
Ellisella																												
Erythropodium																												
Eunicea									2		1											1						
Iciligorgia																												
Muricea																						2				1		
Muriceopsis																												
Plexaura	6	6		1	2	6	2		3	2			2		1							1						
Plexaurella																												
Pseudoplexaura		1			1	4								2														
Pseudopterogorgia	5	10	8	2		10			4	10	2		4	6	1		2	6	1		1	2						
Pterogorgia																						1						

R3-Z1	RP3																RP4															
Octocoral genus	**T9**				**T10**				**T11**				**T12**				**T13**				**T14**				**T15**				**T16**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum					1								2								2				1	1			3			
Ellisella																																
Erythropodium																																
Eunicea																					1											
Iciligorgia																																
Muricea																					1	1										
Muriceopsis																																
Plexaura		1																			1											
Plexaurella																																
Pseudoplexaura																																
Pseudopterogorgia									2	1				1	1			1				1								1		
Pterogorgia																																

R3-Z2	RP1															
Octocoral genus	T1				T2				T3				T4			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum	1		1		6	8				2			10	6		
Ellisella																
Erythropodium																
Eunicea		1								3				1	1	
Iciligorgia																
Muricea	1				1											
Muriceopsis																
Plexaura						2			1				1	10	4	
Plexaurella																
Pseudoplexaura	1		1											1		
Pseudopterogorgia		3	1	1		3	4		4	2	7		1	2	2	
Pterogorgia										1			1			

R3-Z2	RP2															
Octocoral genus	T5				T6				T7				T8			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum					3	11	1		2				6	6	5	
Ellisella																
Erythropodium																
Eunicea																
Iciligorgia																
Muricea										1						
Muriceopsis																
Plexaura						1			1	1			1		1	
Plexaurella																
Pseudoplexaura						1								1		
Pseudopterogorgia						1				2				3		
Pterogorgia																

R3-Z2	RP3															
Octocoral genus	T9				T10				T11				T12			
Size class	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Briareum	2				9	3				1			8	2	2	
Ellisella																
Erythropodium																
Eunicea		1														
Iciligorgia																
Muricea									1							
Muriceopsis																
Plexaura															1	
Plexaurella																
Pseudoplexaura										1						
Pseudopterogorgia	1	3	5			3	2				1		1	1	3	
Pterogorgia																

R3-Z2	RP4											
Octocoral genus	T13				T14				T15			
Size class	1	2	3	4	1	2	3	4	1	2	3	4
Briareum					6	2	2				1	
Ellisella												
Erythropodium												
Eunicea												
Iciligorgia												
Muricea										1		
Muriceopsis												
Plexaura												
Plexaurella												
Pseudoplexaura												
Pseudopterogorgia												
Pterogorgia												

R3-Z3	RP1															
Octocoral genus	**T1**				**T2**				**T3**				**T4**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum					4	5	1		3	2			4	7	1	
Ellisella																
Erythropodium																
Eunicea							1		8	10	1					
Iciligorgia																
Muricea					1											
Muriceopsis												1				
Plexaura					2	10	1			2	2		1	9	2	
Plexaurella																
Pseudoplexaura									1	2	3					
Pseudopterogorgia						2	1	2	2	9	2		1	8		
Pterogorgia																

R3-Z3	RP2											
Octocoral genus	**T5**				**T6**				**T7**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum	1	7	1		4	4			10	5	1	
Ellisella												
Erythropodium												
Eunicea			1			1			1	2		
Iciligorgia												
Muricea												
Muriceopsis												
Plexaura	1				1	1	1			2	2	
Plexaurella												
Pseudoplexaura												
Pseudopterogorgia		8	4		2	6			4	7	2	
Pterogorgia												

R3-Z3	RP3											
Octocoral genus	**T9**				**T10**				**T11**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum		1										
Ellisella												
Erythropodium												
Eunicea												
Iciligorgia												
Muricea												
Muriceopsis												
Plexaura					1							
Plexaurella												
Pseudoplexaura	1											
Pseudopterogorgia		5	5	1								
Pterogorgia						1				2	1	

R3-Z3	RP4											
Octocoral genus	**T13**				**T15**				**T16**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum		1										
Ellisella												
Erythropodium											1	
Eunicea												
Iciligorgia												
Muricea												
Muriceopsis												
Plexaura												
Plexaurella												
Pseudoplexaura												
Pseudopterogorgia												
Pterogorgia						3	1			4		

RI-Z1	RP1																RP2																RP3															
Octocoral genus	**T1**				**T2**				**T3**				**T4**				**T5**				**T6**				**T7**				**T8**				**T9**				**T10**				**T11**				**T12**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum																						1								1			1						1									
Ellisella																																																
Erythropodium																									1																							
Eunicea																									1																							
Iciligorgia																																																
Muricea																																																
Muriceopsis											1																																					
Plexaura																									1													1										
Plexaurella																																																
Pseudoplexaura																																																
Pseudopterogorgia														1			1																															
Pterogorgia																																																

RI-Z2	RP1															
Octocoral genus	**T1**				**T2**				**T3**				**T4**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum	6	4								1	1		6	7	2	
Ellisella															1	
Erythropodium																
Eunicea			1													
Iciligorgia																
Muricea																
Muriceopsis							1									
Plexaura							2									
Plexaurella																
Pseudoplexaura			1													1
Pseudopterogorgia		1				1			1							
Pterogorgia																

RI-Z2	RP2															
Octocoral genus	**T5**				**T6**				**T7**				**T8**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum	1				1	1										
Ellisella																
Erythropodium																
Eunicea																
Iciligorgia																
Muricea																
Muriceopsis							1									
Plexaura																
Plexaurella																
Pseudoplexaura																
Pseudopterogorgia									1	1				1		
Pterogorgia																

RI-Z2	RP3															
Octocoral genus	**T9**				**T10**				**T11**				**T12**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum						1	1		1				1			
Ellisella																
Erythropodium																
Eunicea	1			1												
Iciligorgia																
Muricea																
Muriceopsis																
Plexaura																
Plexaurella																
Pseudoplexaura																
Pseudopterogorgia		1														
Pterogorgia																

RI-Z3	RP1																RP2																RP3															
Octocoral genus	**T1**				**T2**				**T3**				**T4**				**T5**				**T6**				**T7**				**T8**				**T9**				**T10**				**T11**				**T12**			
Size class	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Briareum					5	2											2	7	4		2				1				5	11	1			1			1	1				1						
Ellisella																																																
Erythropodium																																																
Eunicea																																																
Iciligorgia																																																
Muricea																																																
Muriceopsis																																																
Plexaura																																														1		
Plexaurella																																																
Pseudoplexaura																																																
Pseudopterogorgia																																																
Pterogorgia																																																

APPENDIX B

Videographic Data

Project: Dial Cordy Port Everglades
Dataset name:
Location: Reef 3 Control Zone 1
File/sheetname: M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\ControlReef3 Zone1.xls:Data summary

TRANSECT NAME	C-Z1-RP1-T1	C-Z1-RP1-T2	C-Z1-RP1-T3	C-Z1-RP1-T4	C-Z1-RP2-T1	C-Z1-RP2-T2	C-Z1-RP2-T3	C-Z1-RP2-T4	C-Z1-RP3-T1	C-Z1-RP3-T2	C-Z1-RP3-T3	C-Z1-RP3-T4	C-Z1-RP4-T1	C-Z1-RP4-T2	C-Z1-RP4-T3	C-Z1-RP4-T4				
Number of frames	13	16	18	14	23	22	24	24	22	25	21	18	25	24	22	21				
Total points	520	576	648	560	690	660	720	720	660	750	630	540	750	720	660	630				
Total points (minus tape+wand+shadow)	469	518	576	503	602	582	617	619	573	655	555	491	664	635	579	567				
MAJOR CATEGORY (% of transect)																		MEAN	STD. DEV.	STD. ERROR
CORAL	1.07	1.93	1.04	1.59	0.17	1.37	0.32	2.26	1.57	0.61	0.00	1.22	0.45	0.94	0.52	0.88		1.00	0.64	0.16
GORGONIANS	5.54	2.12	1.39	2.98	0.66	4.12	2.92	5.01	3.84	3.97	1.26	2.85	3.61	1.57	4.66	9.52		3.50	2.14	0.54
SPONGES	6.18	7.92	16.67	7.55	3.65	4.81	3.24	4.04	1.75	0.92	0.90	8.96	2.86	2.36	0.86	2.82		4.72	4.08	1.02
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.42	0.00	0.00		0.11	0.36	0.09
ALGAE	49.47	44.02	52.78	46.72	67.77	75.77	92.71	52.67	65.27	60.15	51.71	46.64	70.03	89.45	65.98	71.96		62.69	14.91	3.73
OTHER LIVE	0.00	0.97	0.00	0.40	0.00	0.17	0.00	0.16	0.52	0.15	0.36	0.20	0.00	0.00	0.00	0.18		0.19	0.28	0.07
DEAD CORAL WITH ALGAE	0.00	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.10	0.39	0.10
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	37.74	41.51	28.13	40.76	27.57	13.23	0.81	35.86	27.05	34.20	45.77	40.12	22.59	3.78	27.98	13.40		27.53	13.63	3.41
UNKNOWNS	0.00	0.00	0.00	0.00	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.47	0.00	1.23		0.16	0.33	0.08
TAPE, WAND, SHADOW	9.81	10.07	11.11	10.18	12.75	11.82	14.31	14.03	13.18	12.67	11.90	9.07	11.47	11.81	12.27	10.00		11.65	1.54	0.38
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00				
SUBCATEGORIES (% of transect)																		MEAN	STD. DEV.	STD. ERROR
CORAL																				
Agaricia agaricites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Colpophyllia natans	0.00	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.05	0.19	0.05
Coral (general)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00		0.01	0.04	0.01
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.11	0.03
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.06	0.02
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Meandrina meandrites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Millipora alcicornis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Montastraea cavernosa	0.21	0.77	0.17	0.80	0.17	0.86	0.00	0.81	0.00	0.00	0.00	0.20	0.15	0.16	0.00	0.00		0.27	0.33	0.08
Montastrea faveolata	0.43	0.19	0.52	0.00	0.00	0.00	0.00	0.48	0.35	0.00	0.00	0.61	0.00	0.00	0.00	0.00		0.16	0.23	0.06
Montastrea franksi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.13	0.03
Montastraea annularis species complex	0.43	0.19	0.52	0.00	0.00	0.00	0.00	0.48	0.87	0.00	0.00	0.61	0.00	0.00	0.00	0.00	0.00	0.19	0.36	0.09
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35		0.02	0.09	0.02
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Porites astreoides	0.00	0.00	0.35	0.00	0.00	0.52	0.16	0.00	0.00	0.00	0.00	0.00	0.30	0.31	0.17	0.53		0.15	0.19	0.05
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00		0.01	0.04	0.01
Siderastrea siderea	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.15	0.00	0.20	0.00	0.00	0.17	0.00		0.06	0.09	0.02
Solenastrea bournoni	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00	0.00	0.00	0.20	0.00	0.31	0.00	0.00		0.11	0.23	0.06
Stephanocoenia intersepta	0.00	0.00	0.00	0.60	0.00	0.00	0.16	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.08	0.19	0.05
GORGONIANS																				
Gorgonian	5.54	2.12	1.39	2.98	0.66	4.12	2.92	5.01	3.84	3.97	1.26	2.85	3.61	1.57	4.66	9.52		3.50	2.14	0.54
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SPONGES																				
Agelas clathrodes	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.04	0.01
Anthosigmella varians	0.00	0.00	0.00	0.20	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.05	0.17	0.04
Aplysina sp.	0.21	1.93	0.35	0.80	0.00	0.00	0.00	0.65	0.35	0.15	0.00	1.43	0.00	0.16	0.00	0.00		0.38	0.57	0.14
Callyspongia vaginalis	0.00	0.19	1.91	1.19	0.00	0.00	0.00	0.81	0.17	0.00	0.00	3.05	0.00	0.00	0.00	0.00		0.46	0.89	0.22
Cliona delitrix	0.43	0.77	1.56	0.60	0.00	0.17	0.00	0.00	0.00	0.00	0.00	1.22	0.00	0.31	0.00	0.00		0.32	0.49	0.12
Holopsamma helwigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00

TRANSECT NAME	C-Z1-RP1-T1	C-Z1-RP1-T2	C-Z1-RP1-T3	C-Z1-RP1-T4	C-Z1-RP2-T1	C-Z1-RP2-T2	C-Z1-RP2-T3	C-Z1-RP2-T4	C-Z1-RP3-T1	C-Z1-RP3-T2	C-Z1-RP3-T3	C-Z1-RP3-T4	C-Z1-RP4-T1	C-Z1-RP4-T2	C-Z1-RP4-T3	C-Z1-RP4-T4					
Iotrochota birotulata	0.00	1.74	0.17	1.99	1.00	0.34	0.00	0.48	0.70	0.61	0.00	0.00	0.00	0.00	0.00	0.00		0.44	0.64	0.16	
Ircinia strobilina	0.00	0.39	0.17	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.41	0.15	0.16	0.00	0.18		0.10	0.14	0.03	
Monanchora unguifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Niphates digitalis	0.00	0.77	0.17	0.40	0.17	0.00	0.32	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.18		0.14	0.21	0.05	
Pseudoceratina crassa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.09	0.36	0.09	
Spheciospongia vesparium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.04	0.01	
Sponge	0.00	0.00	0.69	0.40	2.33	3.09	1.62	0.00	0.00	0.00	0.00	0.00	1.81	1.73	0.86	1.76		0.89	1.02	0.25	
Strongylacidon sp.	0.21	0.39	0.35	0.60	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.11	0.19	0.05	
Xestospongia sp.	5.33	1.74	11.28	1.39	0.17	1.03	0.49	0.48	0.35	0.00	0.90	2.85	0.90	0.00	0.00	0.71		1.73	2.89	0.72	
ZOANTHIDS																					
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.42	0.00	0.00		0.11	0.36	0.09	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE																		10.31			
Dictyota	3.41	7.92	4.86	3.58	0.00	0.52	0.32	0.16	0.00	0.31	0.36	1.63	0.75	0.00	0.17	0.00		1.50	2.29	0.57	
Halimeda	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.06	0.16	0.04	
Lyngbya sp.	1.71	1.16	0.69	0.60	0.00	0.00	0.00	1.45	1.22	2.44	0.72	0.00	0.45	0.16	0.17	0.00		0.67	0.74	0.18	
Macroalgae	0.00	0.00	5.73	1.99	11.30	13.40	20.42	0.00	0.00	0.00	0.00	0.00	25.45	22.99	14.68	13.23		8.07	9.26	2.31	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	43.92	34.94	41.49	40.56	56.48	61.86	71.96	51.05	63.53	57.40	50.63	45.01	43.37	66.30	50.95	58.73		52.39	10.49	2.62	
OTHER LIVE																		0.18			
Ascidian	0.00	0.19	0.00	0.40	0.00	0.17	0.00	0.00	0.00	0.15	0.36	0.00	0.00	0.00	0.00	0.00		0.08	0.14	0.03	
Eudistoma sp	0.00	0.77	0.00	0.00	0.00	0.00	0.00	0.16	0.52	0.00	0.00	0.20	0.00	0.00	0.00	0.00		0.10	0.23	0.06	
Total Ascidian	0.00	0.97	0.00	0.40	0.00	0.17	0.00	0.16	0.52	0.15	0.36	0.20	0.00	0.00	0.00	0.00		**0.18**	**0.27**	**0.07**	
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18		0.01	0.04	0.01	
DEAD CORAL WITH ALGAE																					
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Dead gorgonian	0.00	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.10	0.39	0.10	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																					
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																					
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																					
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	34.54	41.51	27.43	40.16	0.00	0.17	0.49	35.06	27.05	34.20	44.86	40.12	1.66	0.63	1.04	0.18		20.57	18.74	4.69	
Sand	3.20	0.00	0.69	0.60	27.57	13.06	0.32	0.81	0.00	0.00	0.90	0.00	20.93	3.15	26.94	13.23		6.96	10.06	2.51	
UNKNOWNS																					
Unknown	0.00	0.00	0.00	0.00	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.47	0.00	1.23		0.16	0.33	0.08	
TAPE, WAND, SHADOW																					
Shadow	0.00	0.00	0.00	0.00	0.50	1.20	0.49	0.00	0.00	0.00	0.00	0.00	0.60	0.79	0.17	0.53		0.27	0.37	0.09	
Tape	0.21	0.58	2.43	1.19	3.32	1.20	2.43	2.26	3.84	3.66	0.72	3.26	2.41	1.89	2.94	1.23		2.10	1.14	0.29	
Wand	10.66	10.62	10.07	10.14	10.80	11.00	13.78	14.05	11.34	10.84	12.79	6.72	9.94	10.71	10.88	9.35		10.86	1.72	0.43	
NOTES (% of transect)																		**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.47	0.00	0.00		0.04	0.12	0.03	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																					
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00		2.08	8.33	2.08	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)																	**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL	5	10	6	8	1	8	2	14	9	4	0	6	3	6	3	5	90	5.63	3.81	0.90	2.17
GORGONIANS	26	11	8	15	4	24	18	31	22	26	7	14	24	10	27	54	321	20.06	12.24	3.06	0.00
SPONGES	29	41	96	36	22	28	20	25	10	8	5	44	19	15	5	16	419	26.19	22.31	5.58	1.94
ZOANTHIDS	0	0	0	0	0	2	0	0	0	0	0	0	0	9	0	0	11	0.69	2.27	0.57	0.00

TRANSECT NAME	C-Z1-RP1-T1	C-Z1-RP1-T2	C-Z1-RP1-T3	C-Z1-RP1-T4	C-Z1-RP2-T1	C-Z1-RP2-T2	C-Z1-RP2-T3	C-Z1-RP2-T4	C-Z1-RP3-T1	C-Z1-RP3-T2	C-Z1-RP3-T3	C-Z1-RP3-T4	C-Z1-RP4-T1	C-Z1-RP4-T2	C-Z1-RP4-T3	C-Z1-RP4-T4					
ALGAE	232	228	304	235	408	441	572	326	374	394	287	229	465	568	382	408	5853	365.81	111.93	27.98	0.56
OTHER LIVE	0	5	0	2	0	1	0	1	3	1	2	1	0	0	0	1	17	1.06	1.39	0.35	0.87
DEAD CORAL WITH ALGAE	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0.50	2.00	0.50	0.00
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	177	215	162	205	166	77	5	222	155	224	254	197	150	24	162	76	2471	154.44	72.86	18.21	0.58
UNKNOWNS	0	0	0	0	1	1	0	0	0	0	0	0	3	3	0	7	15	0.94	1.91	0.48	0.00
TAPE, WAND, SHADOW	51	58	72	57	88	78	103	101	87	95	75	49	86	85	81	63	1229	76.81	17.14	4.28	0.54
TOTAL TRANSECT POINTS	**520**	**576**	**648**	**560**	**690**	**660**	**720**	**720**	**660**	**750**	**630**	**540**	**750**	**720**	**660**	**630**	**10434**				
SUBCATEGORIES (occurring in transect)																	SUMS	MEAN	STD. DEV.	STD. ERROR	SW INDEX
CORAL																					2.17
Agaricia agaricites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.25	1.00	0.25	0.14
Coral (general)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.06	0.25	0.06	0.05
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0.19	0.75	0.19	0.11
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	2	0.13	0.34	0.09	0.08
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Millipora alcicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea cavernosa	1	4	1	4	1	5	0	5	0	0	0	1	1	1	0	0	24	1.50	1.86	0.47	0.35
Montastrea faveolata	2	1	3	0	0	0	0	3	2	0	0	3	0	0	0	0	14	0.88	1.28	0.31	0.29
Montastrea franksi	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0.19	0.75	0.19	0.11
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0.13	0.50	0.13	0.06
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	0	0	2	0	0	3	1	0	0	0	0	0	2	2	1	3	14	0.88	1.15	0.29	0.29
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.06	0.25	0.06	0.05
Siderastrea siderea	0	1	0	0	0	0	0	1	0	1	0	1	0	0	1	0	5	0.31	0.48	0.12	0.16
Solenastrea bournoni	2	0	0	0	0	0	0	5	0	0	0	1	0	2	0	0	10	0.63	1.36	0.34	0.24
Stephanocoenia intersepta	0	0	0	3	0	0	1	0	3	0	0	0	0	0	0	0	7	0.44	1.03	0.26	0.20
GORGONIANS																					0.00
Gorgonian	26	11	8	15	4	24	18	31	22	26	7	14	24	10	27	54	321	20.06	12.24	3.06	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																					1.94
Agelas clathrodes	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0.06	0.25	0.06	0.01
Anthosigmella varians	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	5	0.31	1.01	0.25	0.05
Aplysina sp.	1	10	2	4	0	0	0	4	2	1	0	7	0	1	0	0	32	2.00	2.92	0.73	0.20
Callyspongia vaginalis	0	1	11	6	0	0	0	5	1	0	0	15	0	0	0	0	39	2.44	4.57	1.14	0.22
Cliona delitrix	2	4	9	3	0	1	0	0	0	0	0	6	0	2	0	0	27	1.69	2.65	0.66	0.18
Holopsamma helwigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Iotrochota birotulata	0	9	1	10	6	2	0	3	4	4	0	0	0	0	0	0	39	2.44	3.35	0.84	0.22
Ircinia strobilina	0	2	1	0	0	1	0	0	0	0	0	2	1	1	0	1	9	0.56	0.73	0.18	0.08
Monanchora unguifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Niphates digitalis	0	4	1	2	1	0	2	0	0	1	0	0	0	0	0	1	12	0.75	1.13	0.28	0.10
Pseudoceratina crassa	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	9	0.56	2.25	0.56	0.08
Spheciospongia vesparium	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0.06	0.25	0.06	0.01
Sponge	0	0	4	2	14	18	10	0	0	0	0	0	12	11	5	10	86	5.38	6.15	1.54	0.33
Strongylacidon sp.	1	2	2	3	0	0	0	0	1	0	0	0	0	0	0	0	9	0.56	0.96	0.24	0.08
Xestospongia sp.	25	9	65	7	1	6	3	3	2	0	5	14	6	0	0	4	150	9.38	16.14	4.03	0.37
ZOANTHIDS																					0.00
Palythoa sp.	0	0	0	0	0	2	0	0	0	0	0	0	0	9	0	0	11	0.69	2.27	0.57	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																					0.58
Dictyota	16	41	28	18	0	3	2	1	0	2	2	8	5	0	1	0	127	7.94	11.97	2.99	0.08

TRANSECT NAME	C-Z1-RP1-T1	C-Z1-RP1-T2	C-Z1-RP1-T3	C-Z1-RP1-T4	C-Z1-RP2-T1	C-Z1-RP2-T2	C-Z1-RP2-T3	C-Z1-RP2-T4	C-Z1-RP3-T1	C-Z1-RP3-T2	C-Z1-RP3-T3	C-Z1-RP3-T4	C-Z1-RP4-T1	C-Z1-RP4-T2	C-Z1-RP4-T3	C-Z1-RP4-T4					
Halimeda	2	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	5	0.31	0.87	0.22	0.01
Lyngbya sp.	8	6	4	3	0	0	0	9	7	16	4	0	3	1	1	0	62	3.88	4.46	1.11	0.05
Macroalgae	0	0	33	10	68	78	126	0	0	0	0	0	169	146	85	75	790	49.38	58.59	14.65	0.27
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Turf	206	181	239	204	340	360	444	316	364	376	281	221	288	421	295	333	4869	304.31	79.25	19.81	0.15
OTHER LIVE																					0.87
Ascidian	0	1	0	2	0	1	0	0	0	1	2	0	0	0	0	0	7	0.44	0.73	0.18	0.37
Eudistoma sp	0	4	0	0	0	0	0	1	3	0	0	1	0	0	0	0	9	0.56	1.21	0.30	0.34
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.06	0.25	0.06	0.17
DEAD CORAL WITH ALGAE																					0.00
Dead coral with algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dead gorgonian	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0.50	2.00	0.50	0.00
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																					0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																					0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																					0.58
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	162	215	158	202	0	1	3	217	155	224	249	197	11	4	6	1	1805	112.81	102.27	25.57	0.23
Sand	15	0	4	3	166	76	2	5	0	0	5	0	139	20	156	75	666	41.63	60.88	15.22	0.35
UNKNOWNS																					0.00
Unknown	0	0	0	0	1	1	0	0	0	0	0	0	3	3	0	7	15	0.94	1.91	0.48	0.00
TAPE, WAND, SHADOW																					0.54
Shadow	0	0	0	0	3	7	3	0	0	0	0	0	4	5	1	3	26	1.63	2.25	0.56	0.08
Tape	1	3	14	6	20	7	15	14	22	24	4	16	16	12	17	7	198	12.38	6.98	1.75	0.29
Wand	50	55	58	51	65	64	85	87	65	71	71	33	66	68	63	53	1005	62.81	13.25	3.31	0.16
NOTES (occurring in transect)																	SUMS	MEAN	STD. DEV.	STD. ERROR	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	4	0.25	0.77	0.19	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																					
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0.06	0.25	0.06	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**1.10**	**1.19**	**1.10**	**1.11**	**0.79**	**0.86**	**0.34**	**1.08**	**0.92**	**0.88**	**0.82**	**1.11**	**0.86**	**0.51**	**0.84**	**0.94**					
CORAL	0.05	0.08	0.05	0.07	0.01	0.06	0.02	0.09	0.07	0.03	0.00	0.05	0.02	0.04	0.03	0.04	**0.70**				
GORGONIANS	0.16	0.08	0.06	0.10	0.03	0.13	0.10	0.15	0.13	0.13	0.06	0.10	0.12	0.07	0.14	0.22					
SPONGES	0.17	0.20	0.30	0.20	0.12	0.15	0.11	0.13	0.07	0.04	0.04	0.22	0.10	0.09	0.04	0.10					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00					
ALGAE	0.35	0.36	0.34	0.36	0.26	0.21	0.07	0.34	0.28	0.31	0.34	0.36	0.25	0.10	0.27	0.24					
OTHER LIVE	0.00	0.04	0.00	0.02	0.00	0.01	0.00	0.01	0.03	0.01	0.02	0.01	0.00	0.00	0.00	0.01					
DEAD CORAL WITH ALGAE	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.37	0.36	0.36	0.37	0.36	0.27	0.04	0.37	0.35	0.37	0.36	0.37	0.34	0.12	0.36	0.27					
UNKNOWNS	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.05					
TAPE, WAND, SHADOW																					

Project: Dial Cordy Port Everglades
Dataset name:
Location: Reef 3 Control Zone 2
File/sheetname: M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\ControlReef3 Zone2.xls:Data summary

TRANSECT NAME	C-Z2-RP1-T1	C-Z2-RP1-T2	C-Z2-RP1-T3	C-Z2-RP1-T4	C-Z2-RP2-T1	C-Z2-RP2-T2	C-Z2-RP2-T3	C-Z2-RP2-T4	C-Z2-RP3-T1	C-Z2-RP3-T2	C-Z2-RP3-T3	C-Z2-RP3-T4	C-Z2-RP4-T1	C-Z2-RP4-T2	C-Z2-RP4-T3	C-Z2-RP4-T4				
Number of frames	26	24	23	25	23	23	24	18	25	14	17	18	24	23	23	24				
Total points	780	720	690	750	690	690	720	575	750	495	595	630	720	690	690	720				
Total points (minus tape+wand+shadow)	676	643	603	656	595	601	615	495	662	429	527	551	622	618	618	638				
MAJOR CATEGORY (% of transect)																		**MEAN**	**STD. DEV.**	**STD. ERROR**
CORAL	0.00	0.47	1.66	0.15	0.84	0.00	0.16	1.21	0.60	0.70	0.76	1.27	0.32	0.16	0.65	0.00		0.56	0.50	0.13
GORGONIANS	0.00	0.62	0.00	0.00	0.17	0.33	0.00	0.61	1.06	4.90	8.54	0.91	2.73	1.94	8.58	1.25		1.98	2.87	0.72
SPONGES	1.63	1.87	5.64	0.46	2.18	2.66	4.07	3.64	7.10	3.28	6.83	2.90	4.50	5.83	5.02	2.98		3.78	1.91	0.48
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.00		0.04	0.16	0.04
ALGAE	29.29	63.92	68.66	30.18	71.43	63.73	59.37	70.71	69.94	66.90	60.34	46.48	52.41	81.07	73.79	81.03		61.76	15.49	3.87
OTHER LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.19	0.00	0.00	0.00	0.00	0.00		0.03	0.09	0.02
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	69.08	33.13	23.71	69.05	25.38	33.28	37.40	23.84	20.54	23.78	22.96	48.28	39.87	10.36	10.84	14.26		31.61	17.88	4.47
UNKNOWNS	0.00	0.00	0.33	0.15	0.00	0.00	0.00	0.00	0.45	0.47	0.38	0.18	0.16	0.65	0.49	0.47		0.23	0.23	0.06
TAPE, WAND, SHADOW	13.33	10.69	12.61	12.53	13.77	12.90	14.58	13.91	11.73	13.33	11.43	12.54	13.61	10.43	10.43	11.39		12.45	1.30	0.33
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00				
SUBCATEGORIES (% of transect)																		**MEAN**	**STD. DEV.**	**STD. ERROR**
CORAL																				
Agaricia agaricites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.00	0.00	0.00	0.00		0.03	0.14	0.03
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Colpophyllia natans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Coral (general)	0.00	0.00	0.17	0.00	0.00	0.00	0.16	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.05	0.12	0.03
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Meandrina meandrites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Millipora alcicornis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.32	0.00	0.00	0.00		0.03	0.09	0.02
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Montastraea cavernosa	0.00	0.47	1.33	0.00	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.00	0.00	0.16	0.00		0.21	0.39	0.10
Montastrea faveolata	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00		0.02	0.06	0.01
Montastrea franksi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00		0.01	0.04	0.01
Montastraea annularis complex	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.16	0.00	0.00	0.03	0.07	0.02
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Porites astreoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.15	0.00	0.38	0.18	0.00	0.00	0.00	0.00		0.06	0.11	0.03
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.32	0.00		0.03	0.09	0.02
Siderastrea siderea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Solenastrea bournoni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00		0.11	0.30	0.07
Stephanocoenia intersepta	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.04	0.01
GORGONIANS																		0.56		
Gorgonian	0.00	0.62	0.00	0.00	0.17	0.33	0.00	0.61	1.06	4.90	8.54	0.91	2.73	1.94	8.58	1.25		1.98	2.87	0.72
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SPONGES																				
Agelas clathrodes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.80	0.00	0.00	0.00		0.06	0.20	0.05
Anthosigmella varians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00		0.02	0.06	0.02
Aplysina sp.	0.00	0.16	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.16	0.00		0.06	0.13	0.03
Callyspongia vaginalis	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00		0.02	0.06	0.01
Cliona delitrix	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.76	0.00	0.80	0.16	0.00	0.00		0.15	0.29	0.07
Holopsamma helwigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Iotrochota birotulata	0.15	0.00	2.49	0.30	0.67	0.17	0.33	0.61	0.15	1.17	0.76	0.18	0.00	0.00	0.00	0.00		0.44	0.64	0.16
Ircinia strobilina	0.00	0.00	0.17	0.00	0.00	0.00	0.33	0.40	0.15	0.70	1.14	0.00	0.00	0.00	0.00	0.16		0.19	0.32	0.08
Monanchora unguifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Niphates digitalis	0.15	0.62	0.00	0.00	0.00	0.00	0.16	0.20	0.15	0.00	0.00	0.00	0.32	0.32	0.16	0.00		0.13	0.18	0.04
Pseudoceratina crassa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Spheciospongia vesparium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Sponge	0.74	1.09	2.99	0.00	1.51	1.66	2.11	1.41	2.42	1.40	3.98	1.81	2.09	3.07	2.59	2.35		1.95	0.97	0.24
Strongylacidon sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Xestospongia sp.	0.59	0.00	0.00	0.00	0.00	0.67	1.14	0.81	3.47	0.00	0.19	0.73	0.00	2.27	1.94	0.47		0.77	1.00	0.25
ZOANTHIDS																				
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.00		0.04	0.16	0.04

TRANSECT NAME	C-Z2-RP1-T1	C-Z2-RP1-T2	C-Z2-RP1-T3	C-Z2-RP1-T4	C-Z2-RP2-T1	C-Z2-RP2-T2	C-Z2-RP2-T3	C-Z2-RP2-T4	C-Z2-RP3-T1	C-Z2-RP3-T2	C-Z2-RP3-T3	C-Z2-RP3-T4	C-Z2-RP4-T1	C-Z2-RP4-T2	C-Z2-RP4-T3	C-Z2-RP4-T4					
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE																14.42	0.00	8.92			
Dictyota	0.00	0.00	0.33	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.57	0.18	1.13	0.16	0.00	0.00		0.24	0.45	0.11	
Halimeda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Lyngbya sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	1.06	0.23	0.76	0.18	1.29	0.00	1.29	2.19		0.45	0.67	0.17	
Macroalgae	4.14	10.42	13.43	1.07	6.72	10.65	8.29	7.47	9.52	4.43	4.36	2.18	9.32	14.72	12.78	12.23		8.23	4.13	1.03	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	25.15	53.50	54.89	29.12	64.71	51.58	49.92	63.23	59.37	62.24	54.65	43.92	40.68	66.18	59.71	66.61		52.84	12.57	3.14	
OTHER LIVE																		0.03			
Ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.08	0.02	
Eudistoma sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00		0.01	0.05	0.01	
Total Ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.19	0.00	0.00	0.00	0.00	0.00		**0.03**	**0.09**	**0.02**	
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DEAD CORAL WITH ALGAE																					
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Dead gorgonian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																					
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																					
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																					
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	0.74	0.62	0.50	0.61	2.86	2.16	1.63	1.01	2.11	0.93	1.90	2.54	0.16	0.00	0.00	0.16		1.12	0.95	0.24	
Sand	68.34	32.50	23.22	68.45	22.52	31.11	35.77	22.83	18.43	22.84	21.06	45.74	39.71	10.36	10.84	14.11		30.49	17.80	4.45	
UNKNOWNS																					
Unknown	0.00	0.00	0.33	0.15	0.00	0.00	0.00	0.00	0.45	0.47	0.38	0.18	0.16	0.65	0.49	0.47		0.23	0.23	0.06	
TAPE, WAND, SHADOW																					
Shadow	0.15	0.62	0.83	0.00	0.17	0.33	0.81	0.40	0.60	0.23	0.00	0.54	1.13	0.81	0.16	0.16		0.43	0.34	0.08	
Tape	2.22	2.02	2.32	2.44	2.69	2.00	3.25	3.84	1.96	1.17	1.90	2.36	2.57	2.27	2.75	3.13		2.43	0.63	0.16	
Wand	13.02	9.33	11.28	11.69	13.11	12.48	13.01	11.92	10.73	13.99	11.01	11.43	12.06	8.58	8.74	9.56		11.38	1.64	0.41	
NOTES (% of transect)																		**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																					
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)																	**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL	0	3	10	1	5	0	1	6	4	3	4	7	2	1	4	0	51	3.19	2.83	0.71	1.89
GORGONIANS	0	4	0	0	1	2	0	3	7	21	45	5	17	12	53	8	178	11.13	16.12	4.03	0.00
SPONGES	11	12	34	3	13	16	25	18	47	14	38	16	29	38	31	19	359	22.44	11.85	2.96	1.49
ZOANTHIDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4	0.25	1.00	0.25	0.00
ALGAE	198	411	414	198	425	383	359	350	463	287	318	256	326	501	456	317	5862	366.38	98.53	24.63	0.47
OTHER LIVE	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	3	0.19	0.54	0.14	0.64
DEAD CORAL WITH ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	467	213	143	453	151	200	230	118	136	102	121	266	248	64	67	91	3070	191.88	121.75	30.44	0.15
UNKNOWNS	0	0	2	1	0	0	0	0	3	2	2	1	1	4	3	3	22	1.38	1.36	0.34	0.00
TAPE, WAND, SHADOW	104	77	87	94	95	89	105	80	88	66	68	79	98	72	72	82	1356	84.75	12.28	3.07	0.59
TOTAL TRANSECT POINTS	**780**	**720**	**690**	**750**	**690**	**690**	**720**	**575**	**750**	**495**	**595**	**630**	**720**	**690**	**690**	**720**	**10905**				
SUBCATEGORIES (occurring in transect)																	**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL																					1.89
Agaricia agaricites	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	0.19	0.75	0.19	0.17
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Coral (general)	0	0	1	0	0	0	1	0	3	0	0	0	0	0	0	0	5	0.31	0.79	0.20	0.23
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	C-Z2-RP1-T1	C-Z2-RP1-T2	C-Z2-RP1-T3	C-Z2-RP1-T4	C-Z2-RP2-T1	C-Z2-RP2-T2	C-Z2-RP2-T3	C-Z2-RP2-T4	C-Z2-RP3-T1	C-Z2-RP3-T2	C-Z2-RP3-T3	C-Z2-RP3-T4	C-Z2-RP4-T1	C-Z2-RP4-T2	C-Z2-RP4-T3	C-Z2-RP4-T4					
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Millipora alcicornis	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	3	0.19	0.54	0.14	0.17
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea cavernosa	0	3	8	0	5	0	0	0	0	0	0	3	0	0	1	0	20	1.25	2.35	0.59	0.37
Montastrea faveolata	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0.13	0.34	0.09	0.13
Montastrea franksi	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.06	0.25	0.06	0.08
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	0	0	0	0	0	0	0	1	1	0	2	1	0	0	0	0	5	0.31	0.60	0.15	0.23
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	3	0.19	0.54	0.14	0.17
Siderastrea siderea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Solenastrea bournoni	0	0	0	0	0	0	0	5	0	3	0	0	0	0	0	0	8	0.50	1.41	0.35	0.29
Stephanocoenia intersepta	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.06	0.25	0.06	0.08
GORGONIANS																					0.00
Gorgonian	0	4	0	0	1	2	0	3	7	21	45	5	17	12	53	8	178	11.13	16.12	4.03	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																					1.49
Agelas clathrodes	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	6	0.38	1.26	0.31	0.07
Anthosigmella varians	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2	0.13	0.34	0.09	0.03
Aplysina sp.	0	1	0	1	0	0	0	0	0	0	0	0	3	0	1	0	6	0.38	0.81	0.20	0.07
Callyspongia vaginalis	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	2	0.13	0.34	0.09	0.03
Cliona delitrix	0	0	0	0	0	0	0	0	4	0	4	0	5	1	0	0	14	0.88	1.75	0.44	0.13
Holopsamma helwigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Iotrochota birotulata	1	0	15	2	4	1	2	3	1	5	4	1	0	0	0	0	39	2.44	3.72	0.93	0.24
Ircinia strobilina	0	0	1	0	0	0	2	2	1	3	6	0	0	0	0	1	16	1.00	1.63	0.41	0.14
Monanchora unguifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Niphates digitalis	1	4	0	0	0	0	1	1	1	0	0	0	2	2	1	0	13	0.81	1.11	0.28	0.12
Pseudoceratina crassa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Spheciospongia vesparium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Sponge	5	7	18	0	9	10	13	7	16	6	21	10	13	19	16	15	185	11.56	5.78	1.45	0.34
Strongylacidon sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Xestospongia sp.	4	0	0	0	0	4	7	4	23	0	1	4	0	14	12	3	76	4.75	6.49	1.62	0.33
ZOANTHIDS																					0.00
Palythoa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4	0.25	1.00	0.25	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																					0.47
Dictyota	0	0	2	0	0	9	0	0	0	0	3	1	7	1	0	0	23	1.44	2.73	0.68	0.02
Halimeda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Lyngbya sp.	0	0	0	0	0	0	1	0	7	1	4	1	8	0	8	14	44	2.75	4.25	1.06	0.04
Macroalgae	28	67	81	7	40	64	51	37	63	19	23	12	58	91	79	78	798	49.88	26.74	6.68	0.27
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Turf	170	344	331	191	385	310	307	313	393	267	288	242	253	409	369	425	4997	312.31	75.06	18.77	0.14
OTHER LIVE																					0.64
Ascidian	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0.13	0.50	0.13	0.27
Eudistoma sp	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0.06	0.25	0.06	0.37
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DEAD CORAL WITH ALGAE																					0.00
Dead coral with algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dead gorgonian	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	C-Z2-RP1-T1	C-Z2-RP1-T2	C-Z2-RP1-T3	C-Z2-RP1-T4	C-Z2-RP2-T1	C-Z2-RP2-T2	C-Z2-RP2-T3	C-Z2-RP2-T4	C-Z2-RP3-T1	C-Z2-RP3-T2	C-Z2-RP3-T3	C-Z2-RP3-T4	C-Z2-RP4-T1	C-Z2-RP4-T2	C-Z2-RP4-T3	C-Z2-RP4-T4					
CORALLINE ALGAE																					0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																					0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																					0.15
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	5	4	3	4	17	13	10	5	14	4	10	14	1	0	0	1	105	6.56	5.60	1.40	0.12
Sand	462	209	140	449	134	187	220	113	122	98	111	252	247	64	67	80	2965	185.31	121.37	30.34	0.03
UNKNOWNS																					0.00
Unknown	0	0	2	1	0	0	0	0	3	2	2	1	1	4	3	3	22	1.38	1.36	0.34	0.00
TAPE, WAND, SHADOW																					0.59
Shadow	1	4	5	0	1	2	5	2	4	1	0	3	7	5	1	1	42	2.63	2.13	0.53	0.11
Tape	15	13	14	16	16	12	20	19	13	5	10	13	16	14	17	20	233	14.56	3.81	0.95	0.30
Wand	88	60	68	78	78	75	80	59	71	60	58	63	75	53	54	61	1081	67.56	10.49	2.62	0.18
NOTES (occurring in transect)																	**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																					
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**0.68**	**0.78**	**0.85**	**0.66**	**0.72**	**0.77**	**0.82**	**0.79**	**0.88**	**0.93**	**1.11**	**0.92**	**0.97**	**0.69**	**0.92**	**0.63**					
CORAL	0.00	0.03	0.07	0.01	0.04	0.00	0.01	0.05	0.03	0.03	0.04	0.06	0.02	0.01	0.03	0.00	**0.43**				
GORGONIANS	0.00	0.03	0.00	0.00	0.01	0.02	0.00	0.03	0.05	0.15	0.21	0.04	0.10	0.08	0.21	0.05					
SPONGES	0.07	0.07	0.16	0.02	0.08	0.10	0.13	0.12	0.19	0.11	0.18	0.10	0.14	0.17	0.15	0.10					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00					
ALGAE	0.36	0.29	0.26	0.36	0.24	0.29	0.31	0.25	0.25	0.27	0.30	0.36	0.34	0.17	0.22	0.17					
OTHER LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00					
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.26	0.37	0.34	0.26	0.35	0.37	0.37	0.34	0.33	0.34	0.34	0.35	0.37	0.23	0.24	0.28					
UNKNOWNS	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.02	0.03	0.02	0.01	0.01	0.03	0.03	0.03					
TAPE, WAND, SHADOW																					

Project: Dial Cordy Port Everglades
Dataset name:
Location: Reef 3 Control Zone 3
File/sheetname: M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\Control\Reef3 Zone3.xls:Data summary

TRANSECT NAME	C-Z3-RP1-T1	C-Z3-RP1-T2	C-Z3-RP1-T3	C-Z3-RP1-T4	C-Z3-RP2-T1	C-Z3-RP2-T2	C-Z3-RP2-T3	C-Z3-RP2-T4	C-Z3-RP3-T1	C-Z3-RP3-T2	C-Z3-RP3-T4	C-Z3-RP4-T1	C-Z3-RP4-T2	C-Z3-RP4-T3			
Number of frames	23	24	24	24	23	23	22	21	25	28	28	24	20	21			
Total points	690	720	720	720	690	690	660	630	750	840	840	720	600	630			
Total points (minus tape+wand+shadow)	607	625	626	625	600	607	579	566	662	734	745	635	527	572			
MAJOR CATEGORY (% of transect)															MEAN	STD. DEV.	STD. ERROR
CORAL	0.33	0.64	1.60	0.00	0.83	0.16	0.69	0.18	0.00	0.41	0.94	0.16	0.76	0.35	0.50	0.44	0.12
GORGONIANS	0.33	3.36	0.00	0.00	1.17	0.00	0.00	0.88	4.53	0.82	3.76	4.25	2.09	6.12	1.95	2.07	0.55
SPONGES	2.80	3.84	1.92	2.88	2.00	2.64	4.32	8.66	4.53	1.63	2.15	6.14	5.69	5.94	3.94	2.06	0.55
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALGAE	63.43	78.08	57.03	54.08	73.00	75.12	74.27	62.54	64.35	54.77	45.64	48.50	48.77	42.48	60.15	11.79	3.15
OTHER LIVE	0.00	0.16	0.00	0.00	0.00	0.16	0.17	0.00	0.45	0.00	0.00	0.47	0.19	0.00	0.12	0.17	0.04
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	32.62	13.76	39.30	43.04	22.67	21.42	20.55	27.74	26.13	42.37	47.52	40.47	42.50	45.10	33.23	11.00	2.94
UNKNOWNS	0.49	0.16	0.16	0.00	0.33	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.19	0.05
TAPE, WAND, SHADOW	12.03	13.19	13.06	13.19	13.04	12.03	12.27	10.16	11.73	12.62	11.31	11.81	12.17	9.21	11.99	1.15	0.31
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00			
SUBCATEGORIES (% of transect)															MEAN	STD. DEV.	STD. ERROR
CORAL																	
Agaricia agaricites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colpophyllia natans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.03	0.11	0.03
Coral (general)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Meandrina meandrites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Millipora alcicornis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montastraea cavernosa	0.00	0.32	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.19	0.17	0.13	0.21	0.06
Montastrea faveolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montastrea franksi	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.15	0.44	0.12
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Porites astreoides	0.33	0.16	0.00	0.00	0.17	0.00	0.69	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.20	0.05
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea siderea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.01	0.04	0.01
Solenastrea bournoni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.17	0.04	0.12	0.03
Stephanocoenia intersepta	0.00	0.16	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.03	0.07	0.02
GORGONIANS																	
Gorgonian	0.33	3.36	0.00	0.00	1.17	0.00	0.00	0.88	4.53	0.82	3.76	4.25	2.09	6.12	1.95	2.07	0.55
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPONGES																	
Agelas clathrodes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthosigmella varians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.45	0.00	0.00	0.00	0.00	0.52	0.11	0.21	0.06
Aplysina sp.	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.15	0.68	0.13	0.16	0.19	1.05	0.19	0.30	0.08
Callyspongia vaginalis	0.00	0.00	0.48	0.16	0.00	0.00	0.17	0.00	1.36	0.54	1.07	0.16	1.14	0.35	0.39	0.47	0.13
Cliona delitrix	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.27	0.31	2.28	0.00	0.23	0.60	0.16
Holopsamma helwigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iotrochota birotulata	0.33	0.32	0.00	0.00	0.17	0.00	0.00	3.89	0.00	0.41	0.54	0.00	0.00	0.00	0.40	1.02	0.27

TRANSECT NAME	C-Z3-RP1-T1	C-Z3-RP1-T2	C-Z3-RP1-T3	C-Z3-RP1-T4	C-Z3-RP2-T1	C-Z3-RP2-T2	C-Z3-RP2-T3	C-Z3-RP2-T4	C-Z3-RP3-T1	C-Z3-RP3-T2	C-Z3-RP3-T4	C-Z3-RP4-T1	C-Z3-RP4-T2	C-Z3-RP4-T3					
Ircinia strobilina	0.00	0.96	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.09	0.26	0.07	
Monanchora unguifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Niphates digitalis	0.00	0.00	0.00	0.00	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00		0.06	0.13	0.03	
Pseudoceratina crassa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.21	0.00	0.13	0.63	0.76	0.35		0.22	0.38	0.10	
Spheciospongia vesparium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Sponge	2.14	2.56	1.12	1.28	1.50	2.31	3.11	4.06	0.00	0.00	0.00	0.94	0.57	0.00		1.40	1.29	0.34	
Strongylacidon sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Xestospongia sp.	0.16	0.00	0.00	1.44	0.00	0.00	1.04	0.00	1.06	0.00	0.00	3.94	0.57	3.67		0.85	1.35	0.36	
ZOANTHIDS																			
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE																9.49			
Dictyota	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.41	6.40	2.68	6.48	4.38	4.37		2.83	4.41	1.18	
Halimeda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00		0.02	0.07	0.02	
Lyngbya sp.	0.16	1.60	0.64	0.64	0.67	0.66	1.21	0.18	0.91	0.27	2.95	1.57	2.28	1.57		1.09	0.82	0.22	
Macroalgae	13.18	16.00	9.27	6.08	8.50	7.58	5.70	4.42	0.00	0.00	0.54	3.15	2.09	1.05		5.54	4.96	1.33	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	50.08	60.48	47.12	47.36	63.83	66.89	67.36	57.95	48.04	47.82	39.46	37.32	40.04	35.49		50.66	10.92	2.92	
OTHER LIVE																0.12			
Ascidian	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00		0.04	0.13	0.03	
Eudistoma sp	0.00	0.00	0.00	0.00	0.00	0.16	0.17	0.00	0.00	0.00	0.00	0.47	0.19	0.00		0.07	0.14	0.04	
Total Ascidian	0.00	0.16	0.00	0.00	0.00	0.16	0.17	0.00	0.45	0.00	0.00	0.47	0.19	0.00		**0.12**	**0.17**	**0.04**	
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DEAD CORAL WITH ALGAE																			
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Dead gorgonian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																			
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																			
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																			
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	1.81	2.08	7.99	2.56	0.83	3.13	0.69	3.00	21.45	36.10	45.64	40.47	42.50	45.10		18.10	19.29	5.16	
Sand	30.81	11.68	31.31	40.48	21.83	18.29	19.86	24.73	4.68	6.27	1.88	0.00	0.00	0.00		15.13	13.54	3.62	
UNKNOWNS																			
Unknown	0.49	0.16	0.16	0.00	0.33	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.12	0.19	0.05	
TAPE, WAND, SHADOW																			
Shadow	0.49	0.80	0.64	0.48	0.50	0.82	0.69	0.71	0.00	0.00	0.00	0.00	0.00	0.00		0.37	0.34	0.09	
Tape	3.29	1.92	2.08	2.24	2.33	2.47	2.07	1.06	3.02	2.04	2.15	1.69	4.74	2.45		2.41	0.85	0.23	
Wand	9.68	12.48	12.30	12.48	12.17	10.38	11.23	9.54	10.27	12.40	10.60	11.50	9.11	7.69		10.86	1.48	0.39	
NOTES (% of transect)																**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																			
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)															**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL	2	4	10	0	5	1	4	1	0	3	7	1	4	2	44	3.14	2.82	0.75	1.70
GORGONIANS	2	21	0	0	7	0	0	5	30	6	28	27	11	35	172	12.29	13.01	3.48	0.00
SPONGES	17	24	12	16	12	16	25	49	30	12	16	39	30	34	334	23.86	11.33	3.03	1.89
ZOANTHIDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE	385	468	357	338	438	456	430	354	426	402	340	308	257	243	5222	373.00	72.80	19.46	0.59

TRANSECT NAME	C-Z3-RP1-T1	C-Z3-RP1-T2	C-Z3-RP1-T3	C-Z3-RP1-T4	C-Z3-RP2-T1	C-Z3-RP2-T2	C-Z3-RP2-T3	C-Z3-RP2-T4	C-Z3-RP3-T1	C-Z3-RP3-T2	C-Z3-RP3-T4	C-Z3-RP4-T1	C-Z3-RP4-T2	C-Z3-RP4-T3					
OTHER LIVE	0	1	0	0	0	1	1	0	3	0	0	3	1	0	10	0.71	1.07	0.29	0.67
DEAD CORAL WITH ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	198	86	246	269	136	130	119	157	173	311	354	257	224	258	2918	208.43	78.57	21.00	0.69
UNKNOWNS	3	1	1	0	2	3	0	0	0	0	0	0	0	0	10	0.71	1.14	0.30	0.00
TAPE, WAND, SHADOW	83	95	94	95	90	83	81	64	88	106	95	85	73	58	1190	85.00	12.99	3.47	0.58
TOTAL TRANSECT POINTS	**690**	**720**	**720**	**720**	**690**	**690**	**660**	**630**	**750**	**840**	**840**	**720**	**600**	**630**	**9900**				
SUBCATEGORIES (occurring in transect)															**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL																			1.70
Agaricia agaricites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0.21	0.80	0.21	0.18
Coral (general)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Millipora alcicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea cavernosa	0	2	0	0	4	0	0	0	0	0	3	0	1	1	11	0.79	1.31	0.35	0.35
Montastrea faveolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastrea franksi	0	0	10	0	0	0	0	0	0	0	0	0	3	0	13	0.93	2.73	0.73	0.36
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	2	1	0	0	1	0	4	1	0	0	0	0	0	0	9	0.64	1.15	0.31	0.32
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea siderea	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0.07	0.27	0.07	0.09
Solenastrea bournoni	0	0	0	0	0	0	0	0	0	3	0	0	0	1	4	0.29	0.83	0.22	0.22
Stephanocoenia intersepta	0	1	0	0	0	1	0	0	0	0	0	1	0	0	3	0.21	0.43	0.11	0.18
GORGONIANS																			0.00
Gorgonian	2	21	0	0	7	0	0	5	30	6	28	27	11	35	172	12.29	13.01	3.48	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																			1.89
Agelas clathrodes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Anthosigmella varians	0	0	0	0	0	0	0	3	3	0	0	0	0	3	9	0.64	1.28	0.34	0.10
Aplysina sp.	1	0	0	0	0	0	0	1	1	5	1	1	1	6	17	1.21	1.89	0.50	0.15
Callyspongia vaginalis	0	0	3	1	0	0	1	0	9	4	8	1	6	2	35	2.50	3.11	0.83	0.24
Cliona delitrix	0	0	0	0	0	0	0	0	2	0	2	2	12	0	18	1.29	3.20	0.85	0.16
Holopsamma helwigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Iotrochota birotulata	2	2	0	0	1	0	0	22	0	3	4	0	0	0	34	2.43	5.79	1.55	0.23
Ircinia strobilina	0	6	2	0	0	0	0	0	0	0	0	0	0	0	8	0.57	1.65	0.44	0.09
Monanchora unguifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Niphates digitalis	0	0	0	0	2	2	0	0	0	0	0	0	1	0	5	0.36	0.74	0.20	0.08
Pseudoceratina crassa	0	0	0	0	0	0	0	0	8	0	1	4	4	2	19	1.36	2.41	0.64	0.16
Spheciospongia vesparium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Sponge	13	16	7	8	9	14	18	23	0	0	0	6	3	0	117	8.36	7.52	2.01	0.37
Strongylacidon sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Xestospongia sp.	1	0	0	9	0	0	6	0	7	0	0	25	3	21	72	5.14	8.19	2.19	0.33
ZOANTHIDS																			0.00
Palythoa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																			0.39
Dictyota	0	0	0	0	0	0	0	0	102	47	20	41	23	25	258	18.43	29.21	7.81	0.15
Halimeda	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0.14	0.53	0.14	0.00

TRANSECT NAME	C-Z3-RP1-T1	C-Z3-RP1-T2	C-Z3-RP1-T3	C-Z3-RP1-T4	C-Z3-RP2-T1	C-Z3-RP2-T2	C-Z3-RP2-T3	C-Z3-RP2-T4	C-Z3-RP3-T1	C-Z3-RP3-T2	C-Z3-RP3-T4	C-Z3-RP4-T1	C-Z3-RP4-T2	C-Z3-RP4-T3					
Lyngbya sp.	1	10	4	4	4	4	7	1	6	2	22	10	12	9	96	6.86	5.59	1.49	0.07
Macroalgae	80	100	58	38	51	46	33	25	0	0	4	20	11	6	472	33.71	30.78	8.22	0.22
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Turf	304	378	295	296	383	406	390	328	318	351	294	237	211	203	4394	313.86	84.88	17.34	0.15
OTHER LIVE																			0.67
Ascidian	0	1	0	0	0	0	0	0	3	0	0	0	0	0	4	0.29	0.83	0.22	0.37
Eudistoma sp	0	0	0	0	0	1	1	0	0	0	0	3	1	0	6	0.43	0.85	0.23	0.31
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DEAD CORAL WITH ALGAE																			0.00
Dead coral with algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dead gorgonian	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																			0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																			0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																			0.69
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	11	13	50	16	5	19	4	17	142	265	340	257	224	258	1621	115.79	125.52	33.55	0.33
Sand	187	73	196	253	131	111	115	140	31	46	14	0	0	0	1297	92.64	82.34	22.01	0.36
UNKNOWNS																			0.00
Unknown	3	1	1	0	2	3	0	0	0	0	0	0	0	0	10	0.71	1.14	0.30	0.00
TAPE, WAND, SHADOW																			0.58
Shadow	3	5	4	3	3	5	4	4	0	0	0	0	0	0	31	2.21	2.08	0.56	0.10
Tape	20	12	13	14	14	15	12	6	20	15	16	12	25	14	208	14.86	4.52	1.21	0.30
Wand	60	78	77	78	73	63	85	54	68	91	79	73	48	44	951	67.93	13.16	3.52	0.18
NOTES (occurring in transect)															SUMS	MEAN	STD. DEV.	STD. ERROR	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																			
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**0.82**	**0.76**	**0.84**	**0.80**	**0.76**	**0.69**	**0.73**	**0.91**	**0.94**	**0.82**	**0.96**	**1.06**	**1.01**	**1.08**					
CORAL	0.02	0.03	0.07	0.00	0.04	0.01	0.03	0.01	0.00	0.02	0.04	0.01	0.04	0.02	**0.35**				
GORGONIANS	0.02	0.11	0.00	0.00	0.05	0.00	0.00	0.04	0.14	0.04	0.12	0.13	0.08	0.17					
SPONGES	0.10	0.13	0.08	0.10	0.08	0.10	0.14	0.21	0.14	0.07	0.08	0.17	0.16	0.17					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
ALGAE	0.29	0.19	0.32	0.33	0.23	0.21	0.22	0.29	0.28	0.33	0.36	0.35	0.35	0.36					
OTHER LIVE	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.02	0.00	0.00	0.03	0.01	0.00					
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.37	0.27	0.37	0.36	0.34	0.33	0.33	0.36	0.35	0.36	0.35	0.37	0.36	0.36					
UNKNOWNS	0.03	0.01	0.01	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
TAPE, WAND, SHADOW																			

Project: Dial Cordy Port Everglades																			
Dataset name:																			
Location: Reef 2 Zone 1																			
File/sheetname:	M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\Reef2 Zone1.xls Data summary																		
TRANSECT NAME	**R2-Z1S-RP1-T1**	**R2-Z1S-RP1-T3**	**R2-Z1S-RP1-T4**	**R2-Z1S-RP2-T1**	**R2-Z1S-RP2-T2**	**R2-Z1S-RP2-T3**	**R2-Z1S-RP2-T4**	**R2-Z1N-RP1-T1**	**R2-Z1N-RP1-T2**	**R2-Z1N-RP1-T3**	**R2-Z1N-RP1-T4**	**R2-Z1N-RP2-T1**	**R2-Z1N-RP2-T2**	**R2-Z1N-RP2-T3**	**R2-Z1N-RP2-T4**				
Number of frames	21	22	25	21	24	21	22	20	23	22	22	23	24	21	23				
Total points	630	660	750	630	720	630	660	700	690	660	660	690	720	630	690				
Total points (minus tape+wand+shadow)	554	579	686	559	638	561	572	614	625	594	589	599	648	552	608				
MAJOR CATEGORY (% of transect)																	MEAN	STD. DEV.	STD. ERROR
CORAL	0.36	1.04	0.29	0.18	0.16	0.36	0.35	0.00	0.16	0.67	0.00	0.50	0.62	0.00	0.16		0.32	0.29	0.07
GORGONIANS	2.53	0.69	0.00	0.00	0.00	1.25	0.00	6.51	1.28	8.75	2.38	0.00	0.00	0.00	0.00		1.56	2.65	0.68
SPONGES	0.72	2.25	3.21	0.18	1.88	4.46	0.87	5.05	3.20	0.17	1.53	1.00	1.23	2.17	0.49		1.89	1.51	0.39
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.08	0.02
ALGAE	72.20	74.96	73.32	40.25	62.70	63.28	60.84	75.41	89.60	59.26	41.09	78.63	74.38	70.65	53.95		66.03	13.60	3.51
OTHER LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.15	0.00	0.00		0.03	0.09	0.02
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.04	0.14	0.04
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	24.19	21.07	23.18	59.39	35.27	30.12	37.94	12.38	4.32	30.81	54.67	19.70	23.46	26.81	45.39		29.91	14.86	3.84
UNKNOWNS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	1.12	0.34	0.00	0.17	0.15	0.36	0.00		0.19	0.32	0.08
TAPE, WAND, SHADOW	12.06	12.27	8.53	11.27	11.39	10.95	13.33	12.29	9.42	10.00	10.76	13.19	10.00	12.38	11.88		11.32	1.38	0.36
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00				
SUBCATEGORIES (% of transect)																	MEAN	STD. DEV.	STD. ERROR
CORAL																	0.32		
Agaricia agaricites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Colpophyllia natans	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00		0.03	0.09	0.02
Coral (general)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00		0.02	0.09	0.02
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.05	0.01
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Meandrina meandrites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Millipora alcicornis	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.09	0.02
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00		0.03	0.12	0.03
Montastraea cavernosa	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.05	0.01
Montastrea faveolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Montastrea franksi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.04	0.01
Montastraea annularis species complex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.04	0.12	0.03
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Porites astreoides	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.05	0.01
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Siderastrea siderea	0.36	0.69	0.15	0.18	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00		0.11	0.19	0.05
Solenastrea bournoni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Stephanocoenia intersepta	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.33	0.15	0.00	0.16		0.06	0.10	0.03
GORGONIANS																			
Gorgonian	2.53	0.69	0.00	0.00	0.00	1.25	0.00	6.51	1.28	8.75	2.38	0.00	0.00	0.00	0.00		1.56	2.65	0.68
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SPONGES																			
Agelas clathrodes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.04	0.01
Anthosigmella varians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.13	0.50	0.13
Aplysina sp.	0.36	0.52	1.02	0.00	0.78	0.36	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.21	0.33	0.09
Callyspongia vaginalis	0.00	0.69	0.29	0.00	0.16	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.10	0.20	0.05
Cliona delitrix	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Holopsamma helwigi	0.00	0.00	0.58	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.05	0.15	0.04
Iotrochota birotulata	0.00	0.17	1.02	0.00	0.47	2.14	0.00	0.98	0.00	0.00	0.51	0.00	0.00	0.00	0.00		0.35	0.61	0.16
Ircinia strobilina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00		0.01	0.04	0.01

TRANSECT NAME	R2-Z1S-RP1-T1	R2-Z1S-RP1-T3	R2-Z1S-RP1-T4	R2-Z1S-RP2-T1	R2-Z1S-RP2-T2	R2-Z1S-RP2-T3	R2-Z1S-RP2-T4	R2-Z1N-RP1-T1	R2-Z1N-RP1-T2	R2-Z1N-RP1-T3	R2-Z1N-RP1-T4	R2-Z1N-RP2-T1	R2-Z1N-RP2-T2	R2-Z1N-RP2-T3	R2-Z1N-RP2-T4					
Monanchora unguifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Niphates digitalis	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.06	0.02	
Pseudoceratina crassa	0.18	0.00	0.15	0.00	0.00	0.18	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.07	0.14	0.04	
Spheciospongia vesparium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Sponge	0.00	0.17	0.00	0.00	0.00	0.00	0.00	1.79	3.20	0.17	1.02	0.83	1.23	2.17	0.49		0.74	0.98	0.25	
Strongylacidon sp.	0.00	0.69	0.00	0.00	0.47	1.25	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.17	0.36	0.09	
Xestospongia sp.	0.00	0.00	0.15	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.06	0.01	
ZOANTHIDS																				
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.08	0.02	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE																	6.74			
Dictyota	25.09	8.64	10.50	0.54	2.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16		3.13	6.93	1.79	
Halimeda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Lyngbya sp.	0.18	0.17	0.44	0.00	0.63	0.36	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.14	0.20	0.05	
Macroalgae	0.54	0.00	0.00	0.00	0.00	0.00	0.52	7.98	12.80	5.05	6.28	3.67	4.78	3.62	6.74		3.47	3.85	0.99	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	46.39	66.15	62.39	39.71	60.03	62.92	60.31	67.10	76.80	54.21	34.80	74.96	69.60	67.03	47.04		59.30	12.47	3.22	
OTHER LIVE																	0.03			
Ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Eudistoma sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.15	0.00	0.00		0.03	0.09	0.02	
Total Ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.15	0.00	0.00		**0.03**	**0.09**	**0.02**	
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DEAD CORAL WITH ALGAE																				
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Dead gorgonian	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.04	0.14	0.04	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																				
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																				
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																				
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	19.86	13.47	22.89	34.88	26.18	30.12	31.47	0.00	0.32	0.17	0.17	7.18	3.86	0.18	4.11		12.99	13.23	3.42	
Sand	4.33	7.60	0.29	24.51	9.09	0.00	6.47	12.38	4.00	30.64	54.50	12.52	19.60	26.63	41.28		16.92	15.90	4.10	
UNKNOWNS																				
Unknown	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	1.12	0.34	0.00	0.17	0.15	0.36	0.00		0.19	0.32	0.08	
TAPE, WAND, SHADOW																				
Shadow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.16	0.17	0.00	0.00	0.31	0.00	0.33		0.10	0.16	0.04	
Tape	2.89	3.28	1.17	2.50	2.04	1.78	2.80	2.12	1.28	1.35	1.19	2.67	0.62	2.17	0.66		1.90	0.83	0.22	
Wand	10.83	10.71	8.16	10.20	10.82	10.52	12.59	11.40	8.96	9.60	10.87	12.52	10.19	11.96	12.50		10.79	1.29	0.33	
NOTES (% of transect)																	**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																				
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)																**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL	2	6	2	1	1	2	2	0	1	4	0	3	4	0	1	29	1.93	1.71	0.44	1.97
GORGONIANS	14	4	0	0	0	7	0	40	8	52	14	0	0	0	0	139	9.27	15.89	4.10	0.00
SPONGES	4	13	22	1	12	26	5	31	20	1	9	6	8	12	3	172	11.47	9.21	2.38	1.87
ZOANTHIDS	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0.13	0.52	0.13	0.00
ALGAE	400	434	503	225	400	355	348	463	560	352	242	471	482	390	328	5953	396.87	92.91	23.99	0.41
OTHER LIVE	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	3	0.20	0.56	0.14	0.00
DEAD CORAL WITH ALGAE	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0.20	0.77	0.20	0.00
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	R2-Z1S-RP1-T1	R2-Z1S-RP1-T3	R2-Z1S-RP1-T4	R2-Z1S-RP2-T1	R2-Z1S-RP2-T2	R2-Z1S-RP2-T3	R2-Z1S-RP2-T4	R2-Z1N-RP1-T1	R2-Z1N-RP1-T2	R2-Z1N-RP1-T3	R2-Z1N-RP1-T4	R2-Z1N-RP2-T1	R2-Z1N-RP2-T2	R2-Z1N-RP2-T3	R2-Z1N-RP2-T4					
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	134	122	159	332	225	169	217	76	27	183	322	118	152	148	276	2660	177.33	85.23	22.01	0.68
UNKNOWNS	0	0	0	0	0	0	0	4	7	2	0	1	1	2	0	17	1.13	2.00	0.52	0.00
TAPE, WAND, SHADOW	76	81	64	71	82	69	88	86	65	66	71	91	72	78	82	1142	76.13	8.66	2.24	0.46
TOTAL TRANSECT POINTS	**630**	**660**	**750**	**630**	**720**	**630**	**660**	**700**	**690**	**660**	**660**	**690**	**720**	**630**	**690**	**10120**				
SUBCATEGORIES (occurring in transect)																**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL																				1.97
Agaricia agaricites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	3	0.20	0.56	0.14	0.23
Coral (general)	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0.13	0.52	0.13	0.18
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0.07	0.26	0.07	0.12
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Millipora alcicornis	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.13	0.52	0.13	0.18
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0.20	0.77	0.20	0.23
Montastraea cavernosa	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0.07	0.26	0.07	0.12
Montastrea faveolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastrea franksi	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0.07	0.26	0.07	0.12
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0.07	0.26	0.07	0.12
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea siderea	2	4	1	1	1	0	0	0	0	0	0	1	0	0	0	10	0.67	1.11	0.29	0.37
Solenastrea bournoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Stephanocoenia intersepta	0	0	0	0	0	1	0	0	0	0	0	2	1	0	1	5	0.33	0.62	0.16	0.30
GORGONIANS																				0.00
Gorgonian	14	4	0	0	0	7	0	40	8	52	14	0	0	0	0	139	9.27	15.89	4.10	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																				1.87
Agelas clathrodes	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.07	0.26	0.07	0.03
Anthosigmella varians	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	12	0.80	3.10	0.80	0.19
Aplysina sp.	2	3	7	0	5	2	1	0	0	0	0	0	0	0	0	20	1.33	2.16	0.56	0.25
Callyspongia vaginalis	0	4	2	0	1	2	0	0	0	0	0	0	0	0	0	9	0.60	1.18	0.31	0.15
Cliona delitrix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Holopsamma helwigi	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	5	0.33	1.05	0.27	0.10
Iotrochota birotulata	0	1	7	0	3	12	0	6	0	0	3	0	0	0	0	32	2.13	3.58	0.93	0.31
Ircinia strobilina	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0.07	0.26	0.07	0.03
Monanchora unguifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Niphates digitalis	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0.13	0.35	0.09	0.05
Pseudoceratina crassa	1	0	1	0	0	1	3	0	0	0	0	0	0	0	0	6	0.40	0.83	0.21	0.12
Spheciospongia vesparium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Sponge	0	1	0	0	0	0	0	11	20	1	6	5	8	12	3	67	4.47	5.99	1.55	0.37
Strongylacidon sp.	0	4	0	0	3	7	1	0	0	0	0	0	0	0	0	15	1.00	2.07	0.53	0.21
Xestospongia sp.	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0.13	0.35	0.09	0.05
ZOANTHIDS																				0.00
Palythoa sp.	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0.13	0.52	0.13	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																				0.41
Dictyota	139	50	72	3	13	0	0	0	0	0	0	0	0	0	1	278	18.53	39.67	10.24	0.14
Halimeda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Lyngbya sp.	1	1	3	0	4	2	0	2	0	0	0	0	0	0	0	13	0.87	1.30	0.34	0.01
Macroalgae	3	0	0	0	0	0	3	49	80	30	37	22	31	20	41	316	21.07	23.84	6.16	0.16
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Turf	257	383	428	222	383	353	345	412	480	322	205	449	451	370	286	5346	356.40	84.42	21.80	0.10
OTHER LIVE																				0.00

TRANSECT NAME	R2-Z1S-RP1-T1	R2-Z1S-RP1-T3	R2-Z1S-RP1-T4	R2-Z1S-RP2-T1	R2-Z1S-RP2-T2	R2-Z1S-RP2-T3	R2-Z1S-RP2-T4	R2-Z1N-RP1-T1	R2-Z1N-RP1-T2	R2-Z1N-RP1-T3	R2-Z1N-RP1-T4	R2-Z1N-RP2-T1	R2-Z1N-RP2-T2	R2-Z1N-RP2-T3	R2-Z1N-RP2-T4					
Ascidian	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Eudistoma sp	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	3	0.20	0.56	0.14	0.00
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DEAD CORAL WITH ALGAE																				0.00
Dead coral with algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dead gorgonian	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0.20	0.77	0.20	0.00
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																				0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																				0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																				0.68
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	110	78	157	195	167	169	180	0	2	1	1	43	25	1	25	1154	76.93	77.47	20.00	0.36
Sand	24	44	2	137	58	0	37	76	25	182	321	75	127	147	251	1506	100.40	94.02	24.27	0.32
UNKNOWNS																				0.00
Unknown	0	0	0	0	0	0	0	4	7	2	0	1	1	2	0	17	1.13	2.00	0.52	0.00
TAPE, WAND, SHADOW																				0.46
Shadow	0	0	0	0	0	0	0	3	1	1	0	0	2	0	2	9	0.60	0.99	0.25	0.04
Tape	16	19	8	14	13	10	16	13	8	8	7	16	4	12	4	168	11.20	4.62	1.19	0.28
Wand	60	62	56	57	69	59	72	70	56	57	64	75	66	68	76	965	64.33	6.90	1.78	0.14
NOTES (occurring in transect)																**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																				
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**0.73**	**0.71**	**0.69**	**0.70**	**0.75**	**0.89**	**0.73**	**0.83**	**0.48**	**0.95**	**0.87**	**0.59**	**0.67**	**0.70**	**0.73**					
CORAL	0.02	0.05	0.02	0.01	0.01	0.02	0.02	0.00	0.01	0.03	0.00	0.03	0.03	0.00	0.01					
GORGONIANS	0.09	0.03	0.00	0.00	0.00	0.05	0.00	0.18	0.06	0.21	0.09	0.00	0.00	0.00	0.00					
SPONGES	0.04	0.09	0.11	0.01	0.07	0.14	0.04	0.15	0.11	0.01	0.06	0.05	0.05	0.08	0.03					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00					
ALGAE	0.24	0.22	0.23	0.37	0.29	0.29	0.30	0.21	0.10	0.31	0.37	0.19	0.22	0.25	0.33					
OTHER LIVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00					
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.34	0.33	0.34	0.31	0.37	0.36	0.37	0.26	0.14	0.36	0.33	0.32	0.34	0.35	0.36					
UNKNOWNS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.02	0.00	0.01	0.01	0.02	0.00					
TAPE, WAND, SHADOW																				

Project: Dial Cordy Port Everglades																				
Dataset name:																				
Location: Reef 2 Zone 2																				
File/sheetname:	M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\Reef2 Zone2.xls:Data summary																			
TRANSECT NAME	R2-Z2S-RP1-T1	R2-Z2S-RP1-T2	R2-Z2S-RP1-T3	R2-Z2S-RP1-T4	R2-Z2S-RP2-T1	R2-Z2S-RP2-T2	R2-Z2S-RP2-T3	R2-Z2S-RP2-T4	R2-Z2N-RP1-T1	R2-Z2N-RP1-T2	R2-Z2N-RP1-T3	R2-Z2N-RP1-T4	R2-Z2N-RP2-T1	R2-Z2N-RP2-T2	R2-Z2N-RP2-T3	R2-Z2N-RP2-T4				
Number of frames	27	23	27	25	26	25	26	27	24	21	26	30	30	24	25	26				
Total points	810	690	810	750	780	750	780	810	720	630	780	900	900	720	750	780				
Total points (minus tape+wand+shadow)	714	601	721	658	686	672	688	699	623	551	673	795	786	650	653	680				
MAJOR CATEGORY (% of transect)																		MEAN	STD. DEV.	STD. ERROR
CORAL	0.00	0.00	0.00	0.00	1.75	0.60	0.87	0.43	0.00	0.00	0.74	0.25	0.00	0.00	0.00	1.91		0.41	0.63	0.16
GORGONIANS	0.00	0.00	0.00	0.46	0.00	0.00	0.15	1.29	0.00	0.00	1.49	0.50	0.00	0.77	0.00	1.03		0.35	0.52	0.13
SPONGES	1.12	0.00	1.25	3.95	3.35	2.98	2.03	4.29	0.00	0.00	8.02	9.81	0.00	0.92	0.31	15.59		3.35	4.37	1.09
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
ALGAE	11.34	7.49	28.02	31.31	76.97	70.98	75.44	67.95	11.40	12.70	64.34	65.91	3.44	15.69	15.16	55.00		38.32	28.30	7.07
OTHER LIVE	0.00	0.00	0.00	0.00	0.15	0.00	0.29	0.00	0.00	0.00	0.30	0.13	0.00	0.00	0.15	1.03		0.13	0.26	0.07
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.29	1.72	0.00	0.00	0.30	0.38	0.00	0.00	0.00	1.62		0.27	0.56	0.14
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	87.39	92.51	70.60	64.13	17.35	25.30	20.93	24.18	88.60	87.30	24.81	23.02	96.56	82.62	84.38	23.82		57.09	32.20	8.05
UNKNOWNS	0.14	0.00	0.14	0.15	0.44	0.15	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.07	0.12	0.03
TAPE, WAND, SHADOW	11.85	12.90	10.99	12.27	12.05	10.40	11.79	13.70	13.47	12.54	13.72	11.67	12.67	9.72	12.93	12.82		12.22	1.14	0.28
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00				
SUBCATEGORIES (% of transect)																		MEAN	STD. DEV.	STD. ERROR
CORAL																				
Agaricia agaricites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59		0.04	0.15	0.04
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Colpophyllia natans	0.00	0.00	0.00	0.00	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00		0.10	0.33	0.08
Coral (general)	0.00	0.00	0.00	0.00	0.15	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.08	0.02
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29		0.04	0.10	0.02
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Meandrina meandrites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Millipora alcicornis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Montastraea cavernosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29		0.02	0.07	0.02
Montastrea faveolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.07	0.02
Montastrea franksi	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.04	0.01
Montastraea annularis complex	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.02
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Porites astreoides	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.04	0.01
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.04	0.01
Siderastrea siderea	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.15		0.04	0.09	0.02
Solenastrea bournoni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00		0.03	0.11	0.03
Stephanocoenia intersepta	0.00	0.00	0.00	0.00	0.00	0.15	0.44	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59		0.08	0.18	0.04
GORGONIANS																				
Gorgonian	0.00	0.00	0.00	0.46	0.00	0.00	0.15	1.29	0.00	0.00	1.49	0.50	0.00	0.77	0.00	1.03		0.35	0.52	0.13
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SPONGES																				
Agelas clathrodes	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00		0.04	0.10	0.03
Anthosigmella varians	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.10	0.03
Aplysina sp.	0.00	0.00	0.28	0.00	0.00	0.00	0.29	2.29	0.00	0.00	1.49	3.27	0.00	0.31	0.15	4.71		0.80	1.42	0.36
Callyspongia vaginalis	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.72	0.00	0.00	0.59	0.38	0.00	0.00	0.15	0.59		0.18	0.27	0.07
Cliona delitrix	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	1.63	0.63	0.00	0.31	0.00	0.59		0.23	0.45	0.11
Holopsamma helwigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47		0.09	0.37	0.09
Iotrochota birotulata	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.00	0.15	2.89	0.00	0.00	0.00	1.62		0.35	0.81	0.20
Ircinia strobilina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.25	0.00	0.00	0.00	0.00		0.03	0.09	0.02

TRANSECT NAME	R2-Z2S-RP1-T1	R2-Z2S-RP1-T2	R2-Z2S-RP1-T3	R2-Z2S-RP1-T4	R2-Z2S-RP2-T1	R2-Z2S-RP2-T2	R2-Z2S-RP2-T3	R2-Z2S-RP2-T4	R2-Z2N-RP1-T1	R2-Z2N-RP1-T2	R2-Z2N-RP1-T3	R2-Z2N-RP1-T4	R2-Z2N-RP2-T1	R2-Z2N-RP2-T2	R2-Z2N-RP2-T3	R2-Z2N-RP2-T4					
Monanchora unguifera	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.08	0.02	
Niphates digitalis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.44		0.04	0.12	0.03	
Pseudoceratina crassa	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	1.04	0.88	0.00	0.00	0.00	0.29		0.16	0.33	0.08	
Spheciospongia vesparium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.00		0.04	0.16	0.04	
Sponge	0.98	0.00	0.55	3.95	2.62	2.98	0.00	0.14	0.00	0.00	0.59	0.25	0.00	0.00	0.00	0.00		0.75	1.26	0.32	
Strongylacidon sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	1.49	0.50	0.00	0.31	0.00	0.29		0.19	0.39	0.10	
Xestospongia sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.45	0.00	0.00	0.00	0.00	5.59		0.40	1.39	0.35	
ZOANTHIDS																					
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE																		7.23			
Dictyota	0.00	0.00	0.00	0.00	0.00	0.00	18.17	14.31	0.00	0.00	16.34	22.01	0.00	0.31	0.00	12.94		5.26	8.21	2.05	
Halimeda	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.59	2.14	0.00	0.00	0.00	2.21		0.34	0.74	0.18	
Lyngbya sp.	0.00	0.00	0.00	0.00	0.00	0.00	2.03	0.72	0.00	0.00	0.74	0.13	0.00	0.00	0.00	0.00		0.23	0.54	0.14	
Macroalgae	0.28	0.17	2.08	0.91	11.52	6.55	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.29		1.41	3.16	0.79	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15		0.01	0.04	0.01	
Turf	11.06	7.32	25.94	30.40	65.45	64.43	54.80	52.93	11.40	11.98	46.66	41.64	3.44	15.38	15.16	39.41		31.09	21.24	5.31	
OTHER LIVE																		0.13			
Ascidian	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.29		0.04	0.09	0.02	
Eudistoma sp	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.30	0.13	0.00	0.00	0.00	0.74		0.09	0.20	0.05	
Total Ascidian	0.00	0.00	0.00	0.00	0.15	0.00	0.29	0.00	0.00	0.00	0.30	0.13	0.00	0.00	0.15	1.03		**0.13**	**0.26**	**0.07**	
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DEAD CORAL WITH ALGAE																					
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88		0.08	0.24	0.06	
Dead gorgonian	0.00	0.00	0.00	0.00	0.00	0.00	0.29	1.29	0.00	0.00	0.30	0.38	0.00	0.00	0.00	0.74		0.19	0.36	0.09	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																					
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																					
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																					
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	0.14	0.67	2.36	1.37	2.77	3.72	20.93	24.18	0.00	75.32	23.33	21.26	2.16	22.92	74.12	20.74		18.50	24.08	6.02	
Sand	87.25	91.85	68.24	62.77	14.58	21.58	0.00	0.00	88.60	11.98	1.49	1.76	94.40	59.69	10.26	3.09		38.60	38.37	9.59	
UNKNOWNS																					
Unknown	0.14	0.00	0.14	0.15	0.44	0.15	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.07	0.12	0.03	
TAPE, WAND, SHADOW																					
Shadow	0.28	0.17	0.42	0.61	0.15	0.30	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00		0.13	0.19	0.05	
Tape	2.66	2.00	1.53	2.13	1.75	1.79	2.47	3.86	3.53	4.17	3.57	1.76	3.94	1.08	4.75	1.62		2.66	1.14	0.28	
Wand	10.50	12.65	10.40	11.25	11.81	9.52	10.90	12.02	12.04	10.16	12.33	11.32	10.66	9.69	10.11	13.09		11.15	1.08	0.27	
NOTES (% of transect)																		MEAN	STD. DEV.	STD. ERROR	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																					
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)																	SUMS	MEAN	STD. DEV.	STD. ERROR	SW INDEX
CORAL	0	0	0	0	12	4	6	3	0	0	5	2	0	0	0	13	46	2.81	4.29	1.07	2.20
GORGONIANS	0	0	0	3	0	0	1	9	0	0	10	4	0	5	0	7	39	2.44	3.52	0.88	0.00
SPONGES	8	0	9	26	23	20	14	30	0	0	54	78	0	6	2	106	376	23.50	30.86	7.72	2.28
ZOANTHIDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE	81	45	202	206	528	477	519	475	71	70	433	524	27	102	99	374	4233	264.56	201.01	50.25	0.65
OTHER LIVE	0	0	0	0	1	0	2	0	0	0	2	1	0	0	1	7	14	0.88	1.78	0.45	0.60
DEAD CORAL WITH ALGAE	0	0	0	0	0	0	2	12	0	0	2	3	0	0	0	11	30	1.88	3.88	0.97	0.61
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	R2-Z2S-RP1-T1	R2-Z2S-RP1-T2	R2-Z2S-RP1-T3	R2-Z2S-RP1-T4	R2-Z2S-RP2-T1	R2-Z2S-RP2-T2	R2-Z2S-RP2-T3	R2-Z2S-RP2-T4	R2-Z2N-RP1-T1	R2-Z2N-RP1-T2	R2-Z2N-RP1-T3	R2-Z2N-RP1-T4	R2-Z2N-RP2-T1	R2-Z2N-RP2-T2	R2-Z2N-RP2-T3	R2-Z2N-RP2-T4					
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	624	556	508	422	119	170	144	169	552	481	167	183	759	537	551	162	6105	381.56	214.53	53.63	0.62
UNKNOWNS	1	0	1	1	3	1	0	1	0	0	0	0	0	0	0	0	8	0.50	0.82	0.20	0.00
TAPE, WAND, SHADOW	96	89	89	92	94	78	92	111	97	79	107	105	114	70	97	100	1510	94.38	11.97	2.99	0.54
TOTAL TRANSECT POINTS	**810**	**690**	**810**	**750**	**780**	**750**	**780**	**810**	**720**	**630**	**780**	**900**	**900**	**720**	**750**	**780**	**12360**				
SUBCATEGORIES (occurring in transect)																	**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL																					2.20
Agaricia agaricites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0.25	1.00	0.25	0.22
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	0	0	0	9	0	0	0	0	0	0	2	0	0	0	0	11	0.69	2.27	0.57	0.34
Coral (general)	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	3	0.19	0.54	0.14	0.18
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	4	0.25	0.68	0.17	0.22
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Millipora alcicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea cavernosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0.13	0.50	0.13	0.14
Montastrea faveolata	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0.13	0.50	0.13	0.14
Montastrea franksi	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0.06	0.25	0.06	0.08
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.06	0.25	0.06	0.08
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.06	0.25	0.06	0.08
Siderastrea siderea	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	1	4	0.25	0.58	0.14	0.22
Solenastrea bournoni	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0.19	0.75	0.19	0.18
Stephanocoenia intersepta	0	0	0	0	0	1	3	1	0	0	0	0	0	0	0	4	9	0.56	1.21	0.30	0.32
GORGONIANS																					0.00
Gorgonian	0	0	0	3	0	0	1	9	0	0	10	4	0	5	0	7	39	2.44	3.52	0.88	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																					2.20
Agelas clathrodes	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	4	0.25	0.68	0.17	0.05
Anthosigmella varians	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.19	0.75	0.19	0.04
Aplysina sp.	0	0	2	0	0	0	2	16	0	0	10	26	0	2	1	32	91	5.69	10.17	2.54	0.34
Callyspongia vaginalis	0	0	0	0	3	0	0	5	0	0	4	3	0	0	1	4	20	1.25	1.84	0.46	0.16
Cliona delitrix	0	0	0	0	0	0	4	0	0	0	11	5	0	2	0	4	26	1.63	3.05	0.76	0.18
Holopsamma helwigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0.63	2.50	0.63	0.10
Iotrochota birotulata	0	0	0	0	0	0	6	0	0	0	1	23	0	0	0	11	41	2.56	6.23	1.56	0.24
Ircinia strobilina	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	4	0.25	0.68	0.17	0.05
Monanchora unguifera	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3	0.19	0.54	0.14	0.04
Niphates digitalis	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	3	5	0.31	0.79	0.20	0.06
Pseudoceratina crassa	0	0	0	0	0	0	2	0	0	0	7	7	0	0	0	2	18	1.13	2.39	0.60	0.15
Spheciospongia vesparium	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	5	0.31	1.25	0.31	0.06
Sponge	7	0	4	26	18	20	0	1	0	0	4	2	0	0	0	0	82	5.13	8.43	2.11	0.33
Strongylacidon sp.	0	0	0	0	0	0	0	3	0	0	10	4	0	2	0	2	21	1.31	2.65	0.66	0.16
Xestospongia sp.	0	0	0	0	0	0	0	2	0	0	3	0	0	0	0	38	43	2.69	9.46	2.36	0.25
ZOANTHIDS																					0.00
Palythoa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																					0.65
Dictyota	0	0	0	0	0	0	125	100	0	0	110	175	0	2	0	88	600	37.50	59.78	14.94	0.28
Halimeda	0	0	0	0	0	0	3	0	0	0	4	17	0	0	0	15	39	2.44	5.44	1.36	0.04
Lyngbya sp.	0	0	0	0	0	0	14	5	0	0	5	1	0	0	0	0	25	1.56	3.72	0.93	0.03
Macroalgae	2	1	15	6	79	44	0	0	0	4	0	0	0	0	0	2	153	9.56	21.60	5.40	0.12
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.06	0.25	0.06	0.00
Turf	79	44	187	200	449	433	377	370	71	66	314	331	27	100	99	268	3415	213.44	148.84	37.21	0.17
OTHER LIVE																					0.60

TRANSECT NAME	R2-Z2S-RP1-T1	R2-Z2S-RP1-T2	R2-Z2S-RP1-T3	R2-Z2S-RP1-T4	R2-Z2S-RP2-T1	R2-Z2S-RP2-T2	R2-Z2S-RP2-T3	R2-Z2S-RP2-T4	R2-Z2N-RP1-T1	R2-Z2N-RP1-T2	R2-Z2N-RP1-T3	R2-Z2N-RP1-T4	R2-Z2N-RP2-T1	R2-Z2N-RP2-T2	R2-Z2N-RP2-T3	R2-Z2N-RP2-T4					
Ascidian	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	2	4	0.25	0.58	0.14	0.36
Eudistoma sp	0	0	0	0	0	0	2	0	0	0	2	1	0	0	0	5	10	0.63	1.36	0.34	0.24
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DEAD CORAL WITH ALGAE																					0.61
Dead coral with algae	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	6	9	0.56	1.63	0.41	0.36
Dead gorgonian	0	0	0	0	0	0	2	9	0	0	2	3	0	0	0	5	21	1.31	2.52	0.63	0.25
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																					0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																					0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																					0.62
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	1	4	17	9	19	25	144	169	0	415	157	169	17	149	484	141	1920	120.00	146.59	36.65	0.36
Sand	623	552	492	413	100	145	0	0	552	66	10	14	742	388	67	21	4185	261.56	265.49	66.37	0.26
UNKNOWNS																					0.00
Unknown	1	0	1	1	3	1	0	1	0	0	0	0	0	0	0	0	8	0.50	0.82	0.20	0.00
TAPE, WAND, SHADOW																					0.54
Shadow	2	1	3	4	1	2	0	0	0	0	0	1	0	0	0	0	14	0.88	1.26	0.31	0.04
Tape	19	12	11	14	12	12	17	27	22	23	24	14	31	7	31	11	287	17.94	7.56	1.89	0.32
Wand	75	76	75	74	81	64	75	84	75	56	83	90	83	63	66	89	1209	75.56	9.56	2.39	0.18
NOTES (occurring in transect)																	**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																					
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**0.42**	**0.27**	**0.67**	**0.81**	**0.72**	**0.74**	**0.70**	**0.80**	**0.35**	**0.38**	**0.97**	**0.91**	**0.15**	**0.53**	**0.46**	**1.20**					
CORAL	0.00	0.00	0.00	0.00	0.07	0.03	0.04	0.02	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.08	**0.29**				
GORGONIANS	0.00	0.00	0.00	0.02	0.00	0.00	0.01	0.06	0.00	0.00	0.06	0.03	0.00	0.04	0.00	0.05					
SPONGES	0.05	0.00	0.05	0.13	0.11	0.10	0.08	0.14	0.00	0.00	0.20	0.23	0.00	0.04	0.02	0.29					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
ALGAE	0.25	0.19	0.36	0.36	0.20	0.24	0.21	0.26	0.25	0.26	0.28	0.27	0.12	0.29	0.29	0.33					
OTHER LIVE	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.01	0.05					
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.07					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.12	0.07	0.25	0.28	0.30	0.35	0.33	0.34	0.11	0.12	0.35	0.34	0.03	0.16	0.14	0.34					
UNKNOWNS	0.01	0.00	0.01	0.01	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
TAPE, WAND, SHADOW																					

Project: Dial Cordy Port Everglades																				
Dataset name:																				
Location: Reef 3 Zone 1																				
File/sheetname:	M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\Reef3 Zone1.xls:Data summary																			
TRANSECT NAME	**R3-Z1-RP1-T1**	**R3-Z1-RP1-T2**	**R3-Z1-RP1-T3**	**R3-Z1-RP1-T4**	**R3-Z1-RP2-T1**	**R3-Z1-RP2-T2**	**R3-Z1-RP2-T3**	**R3-Z1-RP2-T4**	**R3-Z1-RP3-T1**	**R3-Z1-RP3-T2**	**R3-Z1-RP3-T3**	**R3-Z1-RP3-T4**	**R3-Z1-RP4-T1**	**R3-Z1-RP4-T2**	**R3-Z1-RP4-T3**	**R3-Z1-RP4-T4**				
Number of frames	**28**	**27**	**29**	**29**	**27**	**24**	**25**	**25**	**22**	**24**	**22**	**21**	**23**	**24**	**26**	**24**				
Total points	**840**	**810**	**870**	**870**	**810**	**720**	**750**	**760**	**610**	**620**	**610**	**605**	**644**	**608**	**780**	**720**				
Total points (minus tape+wand+shadow)	**736**	**718**	**773**	**774**	**730**	**639**	**674**	**674**	**555**	**549**	**546**	**540**	**593**	**564**	**706**	**649**				
MAJOR CATEGORY (% of transect)																		**MEAN**	**STD. DEV.**	**STD. ERROR**
CORAL	0.68	0.84	1.94	0.52	0.68	1.72	0.00	0.45	0.90	1.28	1.28	0.93	0.51	0.53	0.71	0.46		0.84	0.50	0.13
GORGONIANS	6.39	6.41	6.60	4.78	5.48	1.56	0.00	0.30	1.44	0.00	1.10	1.30	0.00	0.71	0.14	0.46		2.29	2.61	0.65
SPONGES	6.79	6.69	4.66	3.75	6.44	9.39	1.34	7.57	6.13	3.46	10.07	7.22	5.40	6.03	4.96	4.01		5.87	2.21	0.55
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	7.20	0.00	0.00	0.18	0.00	1.47	1.11	0.00	0.00	0.00	0.00		0.62	1.81	0.45
ALGAE	65.08	66.43	54.98	56.72	83.70	74.96	71.96	70.33	68.83	67.58	73.08	69.81	82.46	70.57	82.86	78.89		71.14	8.37	2.09
OTHER LIVE	0.14	0.28	0.26	0.26	0.00	0.16	0.15	0.15	0.36	0.00	0.00	0.56	0.00	0.00	0.00	0.00		0.14	0.16	0.04
DEAD CORAL WITH ALGAE	0.54	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.04	0.14	0.03
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	20.11	19.36	31.44	33.98	3.01	4.38	26.41	21.07	21.44	26.96	12.45	18.52	11.64	21.81	10.48	15.56		18.66	8.82	2.20
UNKNOWNS	0.27	0.00	0.00	0.00	0.68	0.63	0.15	0.15	0.72	0.73	0.55	0.56	0.00	0.35	0.85	0.62		0.39	0.31	0.08
TAPE, WAND, SHADOW	12.38	11.36	11.15	11.03	9.88	11.25	10.13	10.13	9.02	11.45	10.49	10.74	7.92	7.24	9.49	9.86		10.22	1.34	0.33
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00				
SUBCATEGORIES (% of transect)																		**MEAN**	**STD. DEV.**	**STD. ERROR**
CORAL																				
Agaricia agaricites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.05	0.01
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00		0.01	0.04	0.01
Colpophyllia natans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Coral (general)	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.15	0.00	0.18	0.00	0.00	0.17	0.00	0.14	0.00		0.05	0.08	0.02
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.00	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.04	0.01
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis decactis	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.07	0.02
Madracis mirabilis	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.10	0.03
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Meandrina meandrites	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.07	0.02
Millipora alcicornis	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.18	0.00	0.55	0.00	0.17	0.35	0.00	0.00		0.10	0.17	0.04
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Montastraea cavernosa	0.00	0.00	0.00	0.00	0.68	0.47	0.00	0.15	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.00		0.12	0.23	0.06
Montastrea faveolata	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.05	0.19	0.05
Montastrea franksi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00		0.02	0.07	0.02
Montastraea species complex	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.07	0.20	0.05
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Porites astreoides	0.27	0.00	0.26	0.00	0.00	0.78	0.00	0.00	0.18	0.73	0.37	0.19	0.00	0.00	0.14	0.46		0.21	0.26	0.06
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.14	0.00		0.03	0.10	0.02
Siderastrea siderea	0.14	0.00	0.39	0.00	0.00	0.00	0.00	0.15	0.36	0.18	0.00	0.00	0.17	0.00	0.00	0.00		0.09	0.13	0.03
Solenastrea bournoni	0.00	0.00	0.13	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.10	0.03
Stephanocoenia intersepta	0.00	0.14	0.26	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.19	0.00	0.00	0.00	0.00		0.05	0.09	0.02
GORGONIANS																		0.84		
Gorgonian	6.39	6.41	6.60	4.78	5.48	1.56	0.00	0.30	1.44	0.00	1.10	1.30	0.00	0.71	0.14	0.46		2.29	2.61	0.65
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SPONGES																				
Agelas clathrodes	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.17	0.00	0.00	0.15		0.05	0.10	0.03
Anthosigmella varians	0.41	0.14	0.26	0.00	0.14	0.00	0.00	0.30	0.72	0.00	0.73	0.00	0.00	0.00	0.14	0.00		0.18	0.25	0.06
Aplysina sp.	1.09	1.39	0.78	0.13	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00		0.23	0.44	0.11
Callyspongia vaginalis	0.27	0.42	0.39	0.00	0.14	0.47	0.59	0.45	0.18	0.36	0.73	0.00	0.00	0.00	0.00	0.00		0.25	0.24	0.06
Cliona delitrix	0.00	0.00	0.91	0.26	0.00	0.16	0.00	0.45	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00		0.13	0.25	0.06
Holopsamma helwigi	0.68	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.08	0.21	0.05
Iotrochota birotulata	0.14	0.84	0.26	0.52	0.00	0.31	0.00	1.19	0.90	0.00	2.38	1.11	0.34	1.60	0.14	0.15		0.62	0.68	0.17
Ircinia strobilina	0.41	0.00	0.00	0.00	0.00	0.31	0.00	0.15	0.36	0.00	0.18	0.19	0.00	0.00	0.00	0.00		0.10	0.15	0.04

TRANSECT NAME	R3-Z1-RP1-T1	R3-Z1-RP1-T2	R3-Z1-RP1-T3	R3-Z1-RP1-T4	R3-Z1-RP2-T1	R3-Z1-RP2-T2	R3-Z1-RP2-T3	R3-Z1-RP2-T4	R3-Z1-RP3-T1	R3-Z1-RP3-T2	R3-Z1-RP3-T3	R3-Z1-RP3-T4	R3-Z1-RP4-T1	R3-Z1-RP4-T2	R3-Z1-RP4-T3	R3-Z1-RP4-T4					
Monanchora unguifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.09	0.02	
Niphates digitalis	0.27	0.00	0.00	0.00	0.55	0.00	0.00	0.00	0.36	0.00	0.00	0.19	0.00	1.24	0.00	0.00		0.16	0.33	0.08	
Pseudoceratina crassa	0.00	1.39	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.14	0.40	0.10	
Spheciospongia vesparium	0.27	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.07	0.02	
Sponge	0.00	0.14	0.26	0.00	5.34	6.42	0.74	4.75	2.34	2.00	4.21	3.15	3.88	3.01	3.54	3.39		2.70	2.03	0.51	
Strongylacidon sp.	0.41	0.00	0.13	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.12	0.36	0.09	
Xestospongia sp.	2.85	1.81	0.65	1.42	0.14	1.72	0.00	0.15	0.54	1.09	1.83	2.59	0.67	0.00	1.13	0.31		1.06	0.91	0.23	
ZOANTHIDS																					
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	7.20	0.00	0.00	0.18	0.00	1.47	1.11	0.00	0.00	0.00	0.00		0.62	1.81	0.45	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE																		10.21			
Dictyota	8.70	4.74	5.30	3.49	0.14	0.31	0.15	1.48	0.18	0.36	0.00	0.00	0.00	0.18	0.00	0.15		1.57	2.60	0.65	
Halimeda	0.00	0.42	0.78	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.10	0.23	0.06	
Lyngbya sp.	0.00	4.87	1.29	3.10	0.27	0.63	0.74	0.15	0.54	0.00	0.00	0.56	0.00	0.00	0.00	0.15		0.77	1.35	0.34	
Macroalgae	0.41	0.00	0.00	0.00	7.53	7.04	6.38	11.87	15.14	6.19	5.49	12.41	17.88	8.16	12.46	13.25		7.76	5.73	1.43	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	55.98	56.41	47.61	49.74	75.75	66.98	64.69	56.82	52.97	61.02	67.58	56.85	64.59	62.23	70.40	65.33		60.93	7.67	1.92	
OTHER LIVE																		0.14			
Ascidian	0.00	0.14	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.05	0.01	
Eudistoma sp	0.14	0.14	0.13	0.26	0.00	0.16	0.15	0.15	0.36	0.00	0.00	0.56	0.00	0.00	0.00	0.00		0.13	0.16	0.04	
Total Ascidian	0.14	0.28	0.26	0.26	0.00	0.16	0.15	0.15	0.36	0.00	0.00	0.56	0.00	0.00	0.00	0.00		**0.14**	**0.16**	**0.04**	
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DEAD CORAL WITH ALGAE																					
Dead coral with algae	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.03	0.01	
Dead gorgonian	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.14	0.03	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																					
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																					
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																					
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	6.39	18.80	31.44	31.78	0.27	0.00	1.19	2.37	2.52	2.37	1.28	0.19	0.00	1.95	0.28	1.08		6.37	10.86	2.72	
Sand	13.72	0.56	0.00	2.20	2.74	4.38	25.22	18.69	18.92	24.59	11.17	18.33	11.64	19.86	10.20	14.48		12.29	8.38	2.10	
UNKNOWNS																					
Unknown	0.27	0.00	0.00	0.00	0.68	0.63	0.15	0.15	0.72	0.73	0.55	0.56	0.00	0.35	0.85	0.62		0.39	0.31	0.08	
TAPE, WAND, SHADOW																					
Shadow	0.00	0.00	0.00	0.00	0.82	1.56	0.74	1.19	0.36	1.46	0.55	0.74	1.01	0.53	1.13	2.16		0.77	0.63	0.16	
Tape	3.13	2.37	3.36	3.10	3.01	2.97	1.93	1.78	0.90	3.46	1.65	1.67	1.01	1.95	1.70	1.85		2.24	0.83	0.21	
Wand	11.01	10.45	9.18	9.30	7.12	8.14	8.61	8.31	8.65	8.01	9.52	9.63	6.58	5.32	7.65	6.93		8.40	1.48	0.37	
NOTES (% of transect)																		MEAN	STD. DEV.	STD. ERROR	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.55	1.11	0.00	0.00	0.00	0.00		0.12	0.30	0.08	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																					
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00		1.25	5.00	1.25	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)																	SUMS	MEAN	STD. DEV.	STD. ERROR	SW INDEX
CORAL	5	6	15	4	5	11	0	3	5	7	7	5	3	3	5	3	87	5.44	3.50	0.88	2.42
GORGONIANS	47	46	51	37	40	10	0	2	8	0	6	7	0	4	1	3	262	16.38	19.81	4.95	0.00
SPONGES	50	48	36	29	47	60	9	51	34	19	55	39	32	34	35	26	604	37.75	13.60	3.40	1.87
ZOANTHIDS	0	0	0	0	0	46	0	0	1	0	8	6	0	0	0	0	61	3.81	11.50	2.88	0.00
ALGAE	479	477	425	439	611	479	485	474	382	371	399	377	489	398	585	512	7382	461.38	70.19	17.55	0.52
OTHER LIVE	1	2	2	2	0	1	1	1	2	0	0	3	0	0	0	0	15	0.94	1.00	0.25	0.39
DEAD CORAL WITH ALGAE	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.31	1.01	0.25	0.50
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	R3-Z1-RP1-T1	R3-Z1-RP1-T2	R3-Z1-RP1-T3	R3-Z1-RP1-T4	R3-Z1-RP2-T1	R3-Z1-RP2-T2	R3-Z1-RP2-T3	R3-Z1-RP2-T4	R3-Z1-RP3-T1	R3-Z1-RP3-T2	R3-Z1-RP3-T3	R3-Z1-RP3-T4	R3-Z1-RP4-T1	R3-Z1-RP4-T2	R3-Z1-RP4-T3	R3-Z1-RP4-T4					
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	148	139	243	263	22	28	178	142	119	148	68	100	69	123	74	101	1965	122.81	67.08	16.77	0.67
UNKNOWNS	2	0	0	0	5	4	1	1	4	4	3	3	0	2	6	4	39	2.44	1.97	0.49	0.00
TAPE, WAND, SHADOW	104	92	97	96	80	81	76	76	55	71	64	65	51	44	74	71	1197	74.81	16.95	4.24	0.72
TOTAL TRANSECT POINTS	840	810	870	870	810	720	750	750	610	620	610	605	644	608	780	720	11617				
SUBCATEGORIES (occurring in transect)																	SUMS	MEAN	STD. DEV.	STD. ERROR	SW INDEX
CORAL																					2.42
Agaricia agaricites	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0.06	0.25	0.06	0.05
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.06	0.25	0.06	0.05
Colpophyllia natans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Coral (general)	0	0	0	0	0	1	0	1	0	1	0	0	1	0	1	0	5	0.31	0.48	0.12	0.16
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0.13	0.34	0.09	0.09
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.13	0.50	0.13	0.09
Madracis mirabilis	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.19	0.75	0.19	0.12
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.13	0.50	0.13	0.09
Millipora alcicornis	0	0	0	0	0	2	0	0	1	0	3	0	1	2	0	0	9	0.56	0.96	0.24	0.23
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea cavernosa	0	0	0	0	5	3	0	1	0	0	0	3	0	0	0	0	12	0.75	1.53	0.38	0.27
Montastrea faveolata	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.38	1.50	0.38	0.18
Montastrea franksi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0.13	0.50	0.13	0.09
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	2	0	2	0	0	5	0	0	1	4	2	1	0	0	1	3	21	1.31	1.58	0.39	0.34
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	3	0.19	0.54	0.14	0.12
Siderastrea siderea	1	0	3	0	0	0	0	1	2	1	0	0	1	0	0	0	9	0.56	0.89	0.22	0.23
Solenastrea bournoni	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	4	0.25	0.77	0.19	0.14
Stephanocoenia intersepta	0	1	2	0	0	0	0	0	1	0	0	1	0	0	0	0	5	0.31	0.60	0.15	0.16
GORGONIANS																					0.00
Gorgonian	47	46	51	37	40	10	0	2	8	0	6	7	0	4	1	3	262	16.38	19.81	4.95	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																					1.87
Agelas clathrodes	0	0	0	0	1	0	0	0	2	0	0	0	1	0	0	1	5	0.31	0.60	0.15	0.04
Anthosigmella varians	3	1	2	0	1	0	0	2	4	0	4	0	0	0	1	0	18	1.13	1.45	0.36	0.10
Aplysina sp.	8	10	6	1	0	0	0	1	0	0	0	0	0	1	0	0	27	1.69	3.24	0.81	0.14
Callyspongia vaginalis	2	3	3	0	1	3	4	3	1	2	4	0	0	0	0	0	26	1.63	1.54	0.39	0.14
Cliona delitrix	0	0	7	2	0	1	0	3	0	0	0	0	2	0	0	0	15	0.94	1.88	0.47	0.09
Holopsamma helwigi	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0.56	1.55	0.39	0.06
Iotrochota birotulata	1	6	2	4	0	2	0	8	5	0	13	6	2	9	1	1	60	3.75	3.80	0.95	0.23
Ircinia strobilina	3	0	0	0	0	2	0	1	2	0	1	1	0	0	0	0	10	0.63	0.96	0.24	0.07
Monanchora unguifera	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0.13	0.50	0.13	0.02
Niphates digitalis	2	0	0	0	4	0	0	0	2	0	0	1	0	7	0	0	16	1.00	1.97	0.49	0.10
Pseudoceratina crassa	0	10	7	0	0	0	0	0	0	0	0	0	0	0	0	0	17	1.06	2.95	0.74	0.10
Spheciospongia vesparium	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.19	0.54	0.14	0.03
Sponge	0	1	2	0	39	41	5	32	13	11	23	17	23	17	25	22	271	16.94	13.42	3.35	0.36
Strongylacidon sp.	3	0	1	11	0	0	0	0	0	0	0	0	0	0	0	0	15	0.94	2.79	0.70	0.09
Xestospongia sp.	21	13	5	11	1	11	0	1	3	6	10	14	4	0	8	2	110	6.88	6.04	1.51	0.31
ZOANTHIDS																					0.00
Palythoa sp.	0	0	0	0	0	46	0	0	1	0	8	6	0	0	0	0	61	3.81	11.50	2.88	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																					0.52
Dictyota	64	34	41	27	1	2	1	10	1	2	0	0	0	1	0	1	185	11.56	19.38	4.85	0.09
Halimeda	0	3	6	3	0	0	0	0	0	0	0	0	0	0	0	0	12	0.75	1.73	0.43	0.01
Lyngbya sp.	0	35	10	24	2	4	5	1	3	0	0	3	0	0	0	1	88	5.50	9.94	2.48	0.05
Macroalgae	3	0	0	0	55	45	43	80	84	34	30	67	106	46	88	86	767	47.94	35.24	8.81	0.24
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Turf	412	405	368	385	553	428	436	383	294	335	369	307	383	351	497	424	6330	395.63	65.64	16.41	0.13
OTHER LIVE																					0.39

TRANSECT NAME	R3-Z1-RP1-T1	R3-Z1-RP1-T2	R3-Z1-RP1-T3	R3-Z1-RP1-T4	R3-Z1-RP2-T1	R3-Z1-RP2-T2	R3-Z1-RP2-T3	R3-Z1-RP2-T4	R3-Z1-RP3-T1	R3-Z1-RP3-T2	R3-Z1-RP3-T3	R3-Z1-RP3-T4	R3-Z1-RP4-T1	R3-Z1-RP4-T2	R3-Z1-RP4-T3	R3-Z1-RP4-T4					
Ascidian	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.13	0.34	0.09	0.27
Eudistoma sp	1	1	1	2	0	1	1	1	2	0	0	3	0	0	0	0	13	0.81	0.91	0.23	0.12
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DEAD CORAL WITH ALGAE																					0.50
Dead coral with algae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.06	0.25	0.06	0.32
Dead gorgonian	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.25	1.00	0.25	0.18
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																					0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																					0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																					0.67
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	47	135	243	246	2	0	8	16	14	13	7	1	0	11	2	7	752	47.00	83.89	20.97	0.37
Sand	101	4	0	17	20	28	170	126	105	135	61	99	69	112	72	94	1213	75.81	50.73	12.68	0.30
UNKNOWNS																					0.00
Unknown	2	0	0	0	5	4	1	1	4	4	3	3	0	2	6	4	39	2.44	1.97	0.49	0.00
TAPE, WAND, SHADOW																					0.72
Shadow	0	0	0	0	6	10	5	8	2	8	3	4	6	3	8	14	77	4.81	4.10	1.03	0.18
Tape	23	17	26	24	22	19	13	12	5	19	9	9	6	11	12	12	239	14.94	6.59	1.65	0.32
Wand	81	75	71	72	52	52	58	56	48	44	52	52	39	30	54	46	881	55.06	13.71	3.43	0.23
NOTES (occurring in transect)																	**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	1	0	3	6	0	0	0	0	10	0.63	1.63	0.41	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																					
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.06	0.25	0.06	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**1.05**	**1.00**	**1.12**	**1.00**	**0.66**	**0.94**	**0.67**	**0.83**	**0.93**	**0.83**	**0.92**	**0.96**	**0.59**	**0.83**	**0.63**	**0.69**					
CORAL	0.03	0.04	0.08	0.03	0.03	0.07	0.00	0.02	0.04	0.06	0.06	0.04	0.03	0.03	0.04	0.02	**0.82**				
GORGONIANS	0.18	0.18	0.18	0.15	0.16	0.07	0.00	0.02	0.06	0.00	0.05	0.06	0.00	0.04	0.01	0.02					
SPONGES	0.18	0.18	0.14	0.12	0.18	0.22	0.06	0.20	0.17	0.12	0.23	0.19	0.16	0.17	0.15	0.13					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.01	0.00	0.06	0.05	0.00	0.00	0.00	0.00					
ALGAE	0.28	0.27	0.33	0.32	0.15	0.22	0.24	0.25	0.26	0.26	0.23	0.25	0.16	0.25	0.16	0.19					
OTHER LIVE	0.01	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.02	0.00	0.00	0.03	0.00	0.00	0.00	0.00					
DEAD CORAL WITH ALGAE	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.32	0.32	0.36	0.37	0.11	0.14	0.35	0.33	0.33	0.35	0.26	0.31	0.25	0.33	0.24	0.29					
UNKNOWNS	0.02	0.00	0.00	0.00	0.03	0.03	0.01	0.01	0.04	0.04	0.03	0.03	0.00	0.02	0.04	0.03					
TAPE, WAND, SHADOW																					

Project: Dial Cordy Port Everglades																				
Dataset name:																				
Location: Reef 3 Zone 2																				
File/sheetname:	M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\Reef3 Zone2.xls:Data summary																			
TRANSECT NAME	**R3-Z2-RP1-T1**	**R3-Z2-RP1-T2**	**R3-Z2-RP1-T3**	**R3-Z2-RP1-T4**	**R3-Z2-RP2-T1**	**R3-Z2-RP2-T2**	**R3-Z2-RP2-T3**	**R3-Z2-RP2-T4**	**R3-Z2-RP3-T1**	**R3-Z2-RP3-T2**	**R3-Z2-RP3-T3**	**R3-Z2-RP3-T4**	**R3-Z2-RP4-T1**	**R3-Z2-RP4-T2**	**R3-Z2-RP4-T3**	**R3-Z2-RP4-T4**				
Number of frames	22	22	21	23	26	23	25	25	35	23	25	24	23	22	22	20				
Total points	610	610	583	615	780	690	750	750	1050	690	750	720	615	584	610	600				
Total points (minus tape+wand+shadow)	532	537	524	556	698	628	668	681	1041	616	662	645	555	521	541	547				
MAJOR CATEGORY (% of transect)																		MEAN	STD. DEV.	STD. ERROR
CORAL	0.75	3.54	0.38	0.90	0.72	0.80	0.75	0.29	0.58	0.65	0.30	0.78	0.36	0.19	0.55	1.28		0.80	0.78	0.19
GORGONIANS	5.08	4.28	3.63	3.42	0.14	1.11	0.30	3.38	2.69	2.44	1.96	3.72	0.00	0.00	0.00	0.37		2.03	1.76	0.44
SPONGES	5.45	6.89	9.16	7.19	2.87	2.07	2.84	5.73	7.20	5.36	3.93	6.98	2.16	1.92	6.10	3.66		4.97	2.23	0.58
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.05	0.20	0.05
ALGAE	77.63	65.74	75.95	80.58	50.57	63.06	53.29	59.77	68.68	57.14	72.05	60.16	35.32	44.91	73.38	61.24		62.47	12.42	3.11
OTHER LIVE	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.55		0.07	0.16	0.04
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	10.71	18.62	10.50	7.19	45.42	32.01	42.81	30.54	20.65	34.42	21.60	28.37	62.16	52.98	19.41	32.72		29.38	15.63	3.91
UNKNOWNS	0.38	0.93	0.38	0.54	0.29	0.16	0.00	0.29	0.19	0.00	0.15	0.00	0.00	0.00	0.18	0.18		0.23	0.25	0.06
TAPE, WAND, SHADOW	12.79	11.97	10.12	9.59	10.51	8.99	10.93	9.20	0.86	10.72	11.73	10.42	9.76	12.29	11.31	8.83		10.00	2.71	0.68
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00				
SUBCATEGORIES (% of transect)																		MEAN	STD. DEV.	STD. ERROR
CORAL																				
Agaricia agaricites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Colpophyllia natans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Coral (general)	0.19	0.00	0.00	0.18	0.43	0.16	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.18	0.00		0.08	0.12	0.03
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Meandrina meandrites	0.00	0.19	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.06	0.01
Millipora alcicornis	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.18	0.00	0.00	0.00		0.04	0.09	0.02
Montastraea annularis	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.09	0.02
Montastraea cavernosa	0.56	0.00	0.00	0.18	0.00	0.16	0.00	0.29	0.10	0.16	0.15	0.00	0.00	0.00	0.00	0.37		0.12	0.17	0.04
Montastrea faveolata	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55		0.05	0.14	0.04
Montastrea franksi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.02	0.01
Montastraea annularis complex	0.00	0.19	0.00	0.36	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.07	0.16	0.04
Mycetophyllia aliciae	0.00	2.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.19	0.74	0.19
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Porites astreoides	0.00	0.00	0.19	0.18	0.00	0.32	0.15	0.00	0.00	0.16	0.15	0.47	0.00	0.00	0.00	0.18		0.11	0.14	0.03
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Siderastrea siderea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.19	0.00	0.00		0.02	0.06	0.02
Solenastrea bournoni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00		0.01	0.05	0.01
Stephanocoenia intersepta	0.00	0.00	0.19	0.00	0.29	0.00	0.60	0.00	0.10	0.00	0.00	0.31	0.18	0.00	0.18	0.18		0.13	0.17	0.04
GORGONIANS																		0.80		
Gorgonian	5.08	4.28	3.63	3.42	0.14	1.11	0.30	3.38	2.69	2.44	1.96	3.72	0.00	0.00	0.00	0.37		2.03	1.76	0.44
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
SPONGES																				
Agelas clathrodes	0.19	0.00	0.00	0.72	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00		0.08	0.18	0.05
Anthosigmella varians	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.31	0.00	0.00	0.00	0.00		0.05	0.12	0.03
Aplysina sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.32	0.00	0.00	0.00	0.00	0.00	0.00		0.06	0.16	0.04
Callyspongia vaginalis	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.58	0.00	0.00		0.08	0.19	0.05
Cliona delitrix	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.04	0.14	0.04
Holopsamma helwigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Iotrochota birotulata	0.00	1.12	1.72	0.72	0.86	0.32	0.75	0.73	0.00	0.32	0.00	0.47	0.00	0.00	1.11	0.55		0.54	0.50	0.13
Ircinia strobilina	0.00	0.00	0.19	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.36	0.00	0.00	0.18		0.10	0.21	0.05

TRANSECT NAME	R3-Z2-RP1-T1	R3-Z2-RP1-T2	R3-Z2-RP1-T3	R3-Z2-RP1-T4	R3-Z2-RP2-T1	R3-Z2-RP2-T2	R3-Z2-RP2-T3	R3-Z2-RP2-T4	R3-Z2-RP3-T1	R3-Z2-RP3-T2	R3-Z2-RP3-T3	R3-Z2-RP3-T4	R3-Z2-RP4-T1	R3-Z2-RP4-T2	R3-Z2-RP4-T3	R3-Z2-RP4-T4					
Monanchora unguifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Niphates digitalis	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.15	0.10	0.32	0.00	0.62	0.00	0.19	0.00	0.00		0.10	0.17	0.04	
Pseudoceratina crassa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00		0.01	0.05	0.01	
Spheciospongia vesparium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Sponge	3.20	5.03	3.24	2.52	1.86	1.43	2.10	4.70	3.55	4.22	3.17	3.72	1.26	1.15	2.40	2.74		2.89	1.18	0.30	
Strongylacidon sp.	0.00	0.00	0.00	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.04	0.18	0.04	
Xestospongia sp.	1.50	0.74	4.01	1.98	0.00	0.32	0.00	0.00	2.40	0.00	0.60	1.09	0.54	0.00	2.22	0.18		0.97	1.16	0.29	
ZOANTHIDS																					
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.05	0.20	0.05	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE																		10.10			
Dictyota	0.94	3.72	2.29	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.37	0.73		0.57	1.04	0.26	
Halimeda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Lyngbya sp.	0.75	0.56	1.15	7.91	0.00	0.32	0.45	0.29	0.38	0.00	0.30	0.16	0.00	0.19	0.92	0.37		0.86	1.91	0.48	
Macroalgae	15.98	11.92	12.60	11.69	8.02	6.21	6.89	6.31	11.53	7.31	10.42	8.22	2.70	3.26	6.84	10.79		8.67	3.62	0.90	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	59.96	49.53	59.92	60.25	44.56	56.53	45.96	53.16	56.77	49.84	61.33	51.78	32.61	41.07	65.25	49.36		52.37	8.58	2.14	
OTHER LIVE																		0.07			
Ascidian	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.04	0.01	
Eudistoma sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.55		0.06	0.16	0.04	
Total Ascidian	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.55		**0.07**	**0.16**	**0.04**	
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DEAD CORAL WITH ALGAE																					
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Dead gorgonian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																					
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																					
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																					
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	0.56	2.05	0.00	0.18	1.15	2.23	3.14	1.62	0.77	3.41	2.57	1.24	3.60	6.14	2.22	3.47		2.15	1.58	0.40	
Sand	10.15	16.57	10.50	7.01	44.27	29.78	39.67	28.93	19.88	31.01	19.03	27.13	58.66	46.83	17.19	29.25		27.24	14.50	3.63	
UNKNOWNS																					
Unknown	0.38	0.93	0.38	0.54	0.29	0.16	0.00	0.29	0.19	0.00	0.15	0.00	0.00	0.00	0.18	0.18		0.23	0.25	0.06	
TAPE, WAND, SHADOW																					
Shadow	0.56	0.19	0.75	0.90	0.29	0.48	0.60	0.44	0.77	0.97	0.76	0.62	0.18	1.73	0.92	0.91		0.69	0.38	0.09	
Tape	3.01	3.35	2.86	2.70	2.15	1.43	2.40	2.35	0.10	2.92	3.63	2.33	1.08	3.84	2.03	1.46		2.35	0.98	0.25	
Wand	11.09	10.06	7.63	7.01	9.31	7.96	9.28	7.34	0.00	8.12	8.91	8.68	9.55	8.45	9.80	7.31		8.16	2.45	0.61	
NOTES (% of transect)																		MEAN	STD. DEV.	STD. ERROR	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37		0.02	0.09	0.02	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																					
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.57		1.79	7.14	1.79	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)																	SUMS	MEAN	STD. DEV.	STD. ERROR	SW INDEX
CORAL	4	19	2	5	5	5	5	2	5	4	2	5	2	1	3	7	77	4.81	4.15	1.04	2.16
GORGONIANS	27	23	19	19	1	7	2	23	28	15	13	24	0	0	0	2	203	12.69	10.79	2.70	0.00
SPONGES	29	37	48	40	20	13	19	39	75	33	26	45	12	10	33	20	499	31.19	16.63	4.16	1.36
ZOANTHIDS	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5	0.31	1.25	0.31	0.00
ALGAE	413	353	398	448	353	396	356	407	715	352	477	388	196	234	397	335	6218	388.63	111.90	27.98	0.51
OTHER LIVE	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	3	6	0.38	0.89	0.22	0.45
DEAD CORAL WITH ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	R3-Z2-RP1-T1	R3-Z2-RP1-T2	R3-Z2-RP1-T3	R3-Z2-RP1-T4	R3-Z2-RP2-T1	R3-Z2-RP2-T2	R3-Z2-RP2-T3	R3-Z2-RP2-T4	R3-Z2-RP3-T1	R3-Z2-RP3-T2	R3-Z2-RP3-T3	R3-Z2-RP3-T4	R3-Z2-RP4-T1	R3-Z2-RP4-T2	R3-Z2-RP4-T3	R3-Z2-RP4-T4					
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	57	100	55	40	317	201	286	208	215	212	143	183	345	276	105	179	2922	182.63	94.36	23.59	0.25
UNKNOWNS	2	5	2	3	2	1	0	2	2	0	1	0	0	0	1	1	22	1.38	1.36	0.34	0.00
TAPE, WAND, SHADOW	78	73	59	59	82	62	62	69	9	74	88	75	60	73	69	53	1065	66.56	18.19	4.55	0.74
TOTAL TRANSECT POINTS	**610**	**610**	**593**	**615**	**780**	**690**	**750**	**750**	**1050**	**690**	**750**	**720**	**615**	**594**	**610**	**600**	**11017**				
SUBCATEGORIES (occurring in transect)																	**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL																					2.16
Agaricia agaricites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Coral (general)	1	0	0	1	3	1	0	0	0	1	0	0	0	0	1	0	8	0.50	0.82	0.20	0.24
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0.13	0.34	0.09	0.09
Millipora alcicornis	0	1	0	0	0	0	0	0	3	0	0	0	1	0	0	0	5	0.31	0.79	0.20	0.18
Montastraea annularis	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0.13	0.50	0.13	0.09
Montastraea cavernosa	3	0	0	1	0	1	0	2	1	1	1	0	0	0	0	2	12	0.75	0.93	0.23	0.29
Montastrea faveolata	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0.25	0.77	0.19	0.15
Montastrea franksi	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.06	0.25	0.06	0.06
Mycetophyllia aliciae	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	1.00	4.00	1.00	0.33
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	0	0	1	1	0	2	1	0	0	1	1	3	0	0	0	1	11	0.69	0.87	0.22	0.28
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea siderea	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2	0.13	0.34	0.09	0.09
Solenastrea bournoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.06	0.25	0.06	0.06
Stephanocoenia intersepta	0	0	1	0	2	0	4	0	1	0	0	2	1	0	1	1	13	0.81	1.11	0.28	0.30
GORGONIANS																					0.00
Gorgonian	27	23	19	19	1	7	2	23	28	15	13	24	0	0	0	2	203	12.69	10.79	2.70	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																					1.36
Agelas clathrodes	1	0	0	4	0	0	0	1	0	0	0	0	0	0	1	0	7	0.44	1.03	0.26	0.06
Anthosigmella varians	0	0	0	2	0	0	0	0	0	1	0	2	0	0	0	0	5	0.31	0.70	0.18	0.05
Aplysina sp.	0	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	8	0.50	1.55	0.39	0.07
Callyspongia vaginalis	3	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	7	0.44	1.03	0.26	0.06
Cliona delitrix	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	6	0.38	1.50	0.38	0.05
Holopsamma helwigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Iotrochota birotulata	0	6	9	4	6	2	5	5	0	2	0	3	0	0	6	3	51	3.19	2.81	0.70	0.23
Ircinia strobilina	0	0	1	0	1	0	0	0	0	0	0	5	2	0	0	1	10	0.63	1.31	0.33	0.08
Monanchora unguifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Niphates digitalis	0	0	0	1	0	0	0	1	1	2	0	4	0	1	0	0	10	0.63	1.09	0.27	0.08
Pseudoceratina crassa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.06	0.25	0.06	0.01
Spheciospongia vesparium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Sponge	17	27	17	14	13	9	14	32	37	26	21	24	7	6	13	15	292	18.25	8.89	2.22	0.31
Strongylacidon sp.	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4	0.25	1.00	0.25	0.04
Xestospongia sp.	8	4	21	11	0	2	0	0	25	0	4	7	3	0	12	1	98	6.13	7.70	1.93	0.32
ZOANTHIDS																					0.00
Palythoa sp.	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5	0.31	1.25	0.31	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																					0.61
Dictyota	5	20	12	4	0	0	0	0	0	0	0	0	0	2	2	4	49	3.06	5.53	1.38	0.04
Halimeda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Lyngbya sp.	4	3	6	44	0	2	3	2	4	0	2	1	0	1	5	2	79	4.94	10.57	2.64	0.06
Macroalgae	85	64	66	65	42	39	46	43	120	45	69	53	15	17	37	59	865	54.06	25.49	6.37	0.27
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Turf	319	266	314	335	311	355	307	362	591	307	406	334	181	214	353	270	5225	326.56	89.84	22.46	0.15
OTHER LIVE																					0.45

TRANSECT NAME	R3-Z2-RP1-T1	R3-Z2-RP1-T2	R3-Z2-RP1-T3	R3-Z2-RP1-T4	R3-Z2-RP2-T1	R3-Z2-RP2-T2	R3-Z2-RP2-T3	R3-Z2-RP2-T4	R3-Z2-RP3-T1	R3-Z2-RP3-T2	R3-Z2-RP3-T3	R3-Z2-RP3-T4	R3-Z2-RP4-T1	R3-Z2-RP4-T2	R3-Z2-RP4-T3	R3-Z2-RP4-T4					
Ascidian	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.06	0.25	0.06	0.30
Eudistoma sp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	5	0.31	0.87	0.22	0.15
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DEAD CORAL WITH ALGAE																					0.00
Dead coral with algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dead gorgonian	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																					0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																					0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																					0.25
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	3	11	0	1	8	14	21	11	8	21	17	8	20	32	12	19	206	12.88	8.52	2.13	0.19
Sand	54	89	55	39	309	187	265	197	207	191	126	175	325	244	93	160	2716	169.75	89.09	22.27	0.07
UNKNOWNS																					0.00
Unknown	2	5	2	3	2	1	0	2	2	0	1	0	0	0	1	1	22	1.38	1.36	0.34	0.00
TAPE, WAND, SHADOW																					0.74
Shadow	3	1	4	5	2	3	4	3	8	6	5	4	1	9	5	5	68	4.25	2.21	0.55	0.18
Tape	16	18	15	15	15	9	16	16	1	18	24	15	6	20	11	8	223	13.94	5.70	1.42	0.33
Wand	59	54	40	39	65	50	62	50	0	50	59	56	53	44	53	40	774	48.38	15.09	3.77	0.23
NOTES (occurring in transect)																	**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0.13	0.50	0.13	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																					
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0.13	0.50	0.13	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**0.80**	**1.07**	**0.83**	**0.75**	**0.87**	**0.87**	**0.85**	**0.98**	**0.91**	**0.97**	**0.80**	**1.01**	**0.77**	**0.78**	**0.78**	**0.90**					
CORAL	0.04	0.12	0.02	0.04	0.04	0.04	0.04	0.02	0.03	0.03	0.02	0.04	0.02	0.01	0.03	0.06	**0.58**				
GORGONIANS	0.15	0.13	0.12	0.12	0.01	0.05	0.02	0.11	0.10	0.09	0.08	0.12	0.00	0.00	0.00	0.02					
SPONGES	0.16	0.18	0.22	0.19	0.10	0.08	0.10	0.16	0.19	0.16	0.13	0.19	0.08	0.08	0.17	0.12					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
ALGAE	0.20	0.28	0.21	0.17	0.34	0.29	0.34	0.31	0.26	0.32	0.24	0.31	0.37	0.36	0.23	0.30					
OTHER LIVE	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03					
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.24	0.31	0.24	0.19	0.36	0.36	0.36	0.36	0.33	0.37	0.33	0.36	0.30	0.34	0.32	0.37					
UNKNOWNS	0.02	0.04	0.02	0.03	0.02	0.01	0.00	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01					
TAPE, WAND, SHADOW																					

Project: Dial Cordy Port Everglades

Dataset name:

Location: Reef 3 Zone 3

File/sheetname: M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\Reef3 Zone3.xls:Data summary

TRANSECT NAME	R3-Z3-RP1-T1	R3-Z3-RP1-T2	R3-Z3-RP1-T3	R3-Z3-RP1-T4	R3-Z3-RP2-T1	R3-Z3-RP2-T2	R3-Z3-RP2-T3	R3-Z3-RP2-T4	R3-Z3-RP3-T1	R3-Z3-RP3-T2	R3-Z3-RP3-T3	R3-Z3-RP4-T1	R3-Z3-RP4-T3	R3-Z3-RP4-T4			
Number of frames	24	25	25	25	25	22	25	22	19	24	22	19	18	20			
Total points	620	625	625	625	625	616	625	616	590	550	589	595	590	600			
Total points (minus tape+wand+shadow)	561	570	569	553	545	545	555	554	527	503	530	532	521	532			
MAJOR CATEGORY (% of transect)															**MEAN**	**STD. DEV.**	**STD. ERROR**
CORAL	0.89	0.70	2.11	1.08	3.67	0.73	1.98	1.26	0.19	0.80	0.57	1.13	1.15	0.75	1.22	0.87	0.23
GORGONIANS	0.71	0.53	8.61	3.80	6.79	4.59	2.34	3.61	8.92	0.00	0.94	0.38	1.92	0.19	3.09	3.10	0.83
SPONGES	2.50	6.84	4.57	6.15	7.52	5.14	7.75	2.89	3.80	0.40	0.19	4.32	6.14	7.71	4.71	2.53	0.68
ZOANTHIDS	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.08	0.22	0.06
ALGAE	64.53	73.86	74.87	80.47	59.82	63.67	80.00	79.96	30.17	24.25	10.00	60.34	57.39	56.02	58.24	22.03	5.89
OTHER LIVE	0.00	0.00	0.00	0.00	0.00	0.18	0.18	0.18	0.19	0.00	0.00	0.00	0.19	0.19	0.08	0.10	0.03
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	30.48	17.19	8.79	8.32	22.20	25.69	7.75	12.09	56.36	74.55	87.55	32.52	32.63	34.96	32.22	24.71	6.60
UNKNOWNS	0.89	0.53	1.05	0.18	0.00	0.00	0.00	0.00	0.38	0.00	0.00	1.32	0.58	0.19	0.37	0.45	0.12
TAPE, WAND, SHADOW	9.52	8.80	8.96	11.52	12.80	11.53	11.20	10.06	10.68	8.55	10.02	10.59	11.69	11.33	10.52	1.26	0.34
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00			
SUBCATEGORIES (% of transect)															**MEAN**	**STD. DEV.**	**STD. ERROR**
CORAL																	
Agaricia agaricites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colpophyllia natans	0.00	0.00	0.00	0.00	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.44	0.12
Coral (general)	0.53	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.38	0.12	0.21	0.06
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10	0.03
Dichocoenia stokesi	0.00	0.00	0.00	0.00	0.55	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.15	0.04
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Meandrina meandrites	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.04	0.11	0.03
Millipora alcicornis	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.19	0.07	0.16	0.04
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montastraea cavernosa	0.18	0.18	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.38	0.00	0.00	0.11	0.18	0.05
Montastrea faveolata	0.00	0.00	0.00	0.18	0.00	0.00	1.62	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.44	0.12
Montastrea franksi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Porites astreoides	0.18	0.18	0.35	0.36	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.38	0.19	0.19	0.16	0.16	0.04
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea siderea	0.00	0.00	0.18	0.00	0.73	0.37	0.00	0.36	0.19	0.00	0.00	0.00	0.00	0.00	0.13	0.22	0.06
Solenastrea bournoni	0.00	0.18	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.02
Stephanocoenia intersepta	0.00	0.18	0.53	0.36	0.73	0.18	0.36	0.00	0.00	0.20	0.00	0.38	0.00	0.00	0.21	0.23	0.06
GORGONIANS															1.22		
Gorgonian	0.71	0.53	8.61	3.80	6.79	4.59	2.34	3.61	8.92	0.00	0.94	0.38	1.92	0.19	3.09	3.10	0.83
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPONGES																	
Agelas clathrodes	0.00	0.00	0.00	0.18	0.55	0.00	2.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.68	0.18
Anthosigmella varians	0.00	0.00	0.00	0.00	0.00	0.00	1.08	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.30	0.08
Aplysina sp.	0.00	0.00	0.00	0.00	1.83	0.00	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.38	0.29	0.55	0.15
Callyspongia vaginalis	0.00	0.88	0.00	0.18	1.28	0.00	0.18	0.00	0.19	0.00	0.00	0.00	0.19	0.00	0.21	0.39	0.10
Cliona delitrix	0.00	0.00	0.00	0.00	0.00	2.39	0.54	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.64	0.17
Holopsamma helwigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iotrochota birotulata	0.00	0.35	0.88	0.90	1.47	0.37	0.72	0.36	0.00	0.00	0.00	2.07	0.00	1.13	0.59	0.64	0.17
Ircinia strobilina	0.00	0.53	0.18	0.18	0.37	0.00	0.36	0.90	0.00	0.00	0.00	0.00	0.38	0.00	0.21	0.27	0.07

TRANSECT NAME	R3-Z3-RP1-T1	R3-Z3-RP1-T2	R3-Z3-RP1-T3	R3-Z3-RP1-T4	R3-Z3-RP2-T1	R3-Z3-RP2-T2	R3-Z3-RP2-T3	R3-Z3-RP2-T4	R3-Z3-RP3-T1	R3-Z3-RP3-T2	R3-Z3-RP3-T3	R3-Z3-RP4-T1	R3-Z3-RP4-T3	R3-Z3-RP4-T4					
Monanchora unguifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Niphates digitalis	0.18	0.88	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.19	0.19		0.15	0.25	0.07	
Pseudoceratina crassa	0.00	0.00	0.00	0.00	0.37	0.00	0.72	0.18	0.00	0.00	0.19	0.00	0.00	0.00		0.10	0.21	0.06	
Spheciospongia vesparium	0.00	0.00	0.00	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.00		0.12	0.31	0.08	
Sponge	2.32	1.58	2.11	3.62	0.00	0.18	0.18	0.00	0.76	0.40	0.00	1.88	3.45	3.20		1.41	1.37	0.36	
Strongylacidon sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Xestospongia sp.	0.00	2.63	1.05	1.08	0.73	2.20	0.54	0.00	2.85	0.00	0.00	0.00	1.15	2.82		1.08	1.11	0.30	
ZOANTHIDS																			
Palythoa sp.	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00		0.08	0.22	0.06	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE																7.68			
Dictyota	0.00	0.53	0.00	0.00	0.00	0.00	25.95	29.96	0.00	0.00	0.00	0.00	0.00	0.00		4.03	10.17	2.72	
Halimeda	0.00	0.00	0.00	0.00	1.47	1.47	0.00	0.54	0.00	0.00	0.00	0.00	0.00	0.00		0.25	0.54	0.14	
Lyngbya sp.	4.81	3.86	7.03	11.03	0.37	0.00	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00		2.08	3.43	0.92	
Macroalgae	4.63	4.04	3.34	5.24	0.73	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.32	2.01	0.54	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	55.08	65.44	64.50	64.20	57.25	61.65	54.05	47.47	30.17	24.25	10.00	60.34	57.39	56.02		50.56	16.95	4.53	
OTHER LIVE																0.04			
Ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.05	0.01	
Eudistoma sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.19		0.03	0.07	0.02	
Total Ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.19	0.00	0.00	0.00	0.00	0.19		**0.04**	**0.08**	**0.02**	
Other	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.18	0.00	0.00	0.00	0.00	0.19	0.00		0.04	0.08	0.02	
DEAD CORAL WITH ALGAE																			
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Dead gorgonian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																			
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																			
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																			
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	7.49	0.35	0.00	0.36	0.73	2.57	0.18	1.81	12.14	5.17	4.72	4.70	11.71	8.83		4.34	4.27	1.14	
Sand	22.99	16.84	8.79	7.96	21.47	23.12	7.57	10.29	44.21	69.38	82.83	27.82	20.92	26.13		27.88	22.79	6.09	
UNKNOWNS																			
Unknown	0.89	0.53	1.05	0.18	0.00	0.00	0.00	0.00	0.38	0.00	0.00	1.32	0.58	0.19		0.37	0.46	0.12	
TAPE, WAND, SHADOW																			
Shadow	1.25	0.53	0.00	0.72	0.00	0.00	0.00	0.00	1.14	0.20	0.38	1.69	1.92	2.07		0.71	0.77	0.21	
Tape	2.85	1.05	2.46	1.81	2.94	2.57	3.42	1.81	2.47	1.79	3.77	3.01	1.34	1.13		2.32	0.85	0.23	
Wand	6.42	8.07	7.38	10.49	11.74	10.46	9.19	9.39	8.35	7.36	6.98	7.14	9.98	9.59		8.75	1.60	0.43	
NOTES (% of transect)																MEAN	STD. DEV.	STD. ERROR	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																			
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)															SUMS	MEAN	STD. DEV.	STD. ERROR	SW INDEX
CORAL	5	4	12	6	20	4	11	7	1	4	3	6	6	4	93	6.64	4.83	1.29	2.31
GORGONIANS	4	3	49	21	37	25	13	20	47	0	5	2	10	1	237	16.93	17.00	4.54	0.00
SPONGES	14	39	26	34	41	28	43	16	20	2	1	23	32	41	360	25.71	13.87	3.71	2.07
ZOANTHIDS	0	2	0	0	0	0	0	0	0	0	4	0	0	0	6	0.43	1.16	0.31	0.00
ALGAE	362	421	426	445	326	347	444	443	159	122	53	321	299	298	4466	319.00	126.32	33.76	0.54
OTHER LIVE	0	0	0	0	0	1	1	1	1	0	0	0	1	1	6	0.43	0.51	0.14	1.01
DEAD CORAL WITH ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	R3-Z3-RP1-T1	R3-Z3-RP1-T2	R3-Z3-RP1-T3	R3-Z3-RP1-T4	R3-Z3-RP2-T1	R3-Z3-RP2-T2	R3-Z3-RP2-T3	R3-Z3-RP2-T4	R3-Z3-RP3-T1	R3-Z3-RP3-T2	R3-Z3-RP3-T3	R3-Z3-RP4-T1	R3-Z3-RP4-T3	R3-Z3-RP4-T4					
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	171	98	50	46	121	140	43	67	297	375	464	173	170	186	2401	171.50	127.04	33.95	0.39
UNKNOWNS	5	3	6	1	0	0	0	0	2	0	0	7	3	1	28	2.00	2.45	0.65	0.00
TAPE, WAND, SHADOW	59	55	56	72	80	71	70	62	63	47	59	63	69	68	894	63.86	8.48	2.27	0.71
TOTAL TRANSECT POINTS	**620**	**625**	**625**	**625**	**625**	**616**	**625**	**616**	**590**	**550**	**589**	**595**	**590**	**600**	**8491**				
SUBCATEGORIES (occurring in transect)															**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL																			2.31
Agaricia agaricites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	0	0	0	9	0	0	0	0	0	0	0	0	0	9	0.64	2.41	0.64	0.23
Coral (general)	3	0	3	0	0	0	0	0	0	1	0	0	0	2	9	0.64	1.15	0.31	0.23
Coral juvenile	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0.14	0.53	0.14	0.08
Dichocoenia stokesi	0	0	0	0	3	1	0	0	0	0	0	0	0	0	4	0.29	0.83	0.22	0.14
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	0	0	1	0	0	0	0	0	0	0	0	2	0	3	0.21	0.58	0.15	0.11
Millipora alcicornis	0	0	1	0	0	0	0	0	0	0	0	0	3	1	5	0.36	0.84	0.23	0.16
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea cavernosa	1	1	1	0	0	0	0	0	0	0	3	2	0	0	8	0.57	0.94	0.25	0.21
Montastrea faveolata	0	0	0	1	0	0	9	3	0	0	0	0	0	0	13	0.93	2.46	0.66	0.28
Montastrea franksi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	1	1	2	2	0	0	0	0	0	2	0	2	1	1	12	0.86	0.86	0.23	0.26
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea siderea	0	0	1	0	4	2	0	2	1	0	0	0	0	0	10	0.71	1.20	0.32	0.24
Solenastrea bournoni	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	0.14	0.36	0.10	0.08
Stephanocoenia intersepta	0	1	3	2	4	1	2	0	0	1	0	2	0	0	16	1.14	1.29	0.35	0.30
GORGONIANS																			0.00
Gorgonian	4	3	49	21	37	25	13	20	47	0	5	2	10	1	237	16.93	17.00	4.54	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																			2.07
Agelas clathrodes	0	0	0	1	3	0	14	0	0	0	0	0	0	0	18	1.29	3.75	1.00	0.15
Anthosigmella varians	0	0	0	0	0	0	6	2	0	0	0	0	0	0	8	0.57	1.65	0.44	0.08
Aplysina sp.	0	0	0	0	10	0	5	5	0	0	0	0	0	2	22	1.57	3.03	0.81	0.17
Callyspongia vaginalis	0	5	0	1	7	0	1	0	1	0	0	0	1	0	16	1.14	2.14	0.57	0.14
Cliona delitrix	0	0	0	0	0	13	3	1	0	0	0	0	0	0	17	1.21	3.49	0.93	0.14
Holopsamma helwigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Iotrochota birotulata	0	2	5	5	8	2	4	2	0	0	0	11	0	6	45	3.21	3.45	0.92	0.26
Ircinia strobilina	0	3	1	1	2	0	2	5	0	0	0	0	2	0	16	1.14	1.51	0.40	0.14
Monanchora unguifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Niphates digitalis	1	5	2	0	0	0	0	0	0	0	0	2	1	1	12	0.86	1.41	0.38	0.11
Pseudoceratina crassa	0	0	0	0	2	0	4	1	0	0	1	0	0	0	8	0.57	1.16	0.31	0.08
Spheciospongia vesparium	0	0	0	0	5	0	0	0	0	0	0	0	4	0	9	0.64	1.65	0.44	0.09
Sponge	13	9	12	20	0	1	1	0	4	2	0	10	18	17	107	7.64	7.40	1.98	0.36
Strongylacidon sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Xestospongia sp.	0	15	6	6	4	12	3	0	15	0	0	0	6	15	82	5.86	6.02	1.61	0.34
ZOANTHIDS																			0.00
Palythoa sp.	0	2	0	0	0	0	0	0	0	0	4	0	0	0	6	0.43	1.16	0.31	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																			0.54
Dictyota	0	3	0	0	0	0	144	166	0	0	0	0	0	0	313	22.36	56.37	15.06	0.19
Halimeda	0	0	0	0	8	8	0	3	0	0	0	0	0	0	19	1.36	2.92	0.78	0.02
Lyngbya sp.	27	22	40	61	2	0	0	11	0	0	0	0	0	0	163	11.64	19.14	5.11	0.12
Macroalgae	26	23	19	29	4	3	0	0	0	0	0	0	0	0	104	7.43	11.30	3.02	0.09
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	R3-Z3-RP1-T1	R3-Z3-RP1-T2	R3-Z3-RP1-T3	R3-Z3-RP1-T4	R3-Z3-RP2-T1	R3-Z3-RP2-T2	R3-Z3-RP2-T3	R3-Z3-RP2-T4	R3-Z3-RP3-T1	R3-Z3-RP3-T2	R3-Z3-RP3-T3	R3-Z3-RP4-T1	R3-Z3-RP4-T3	R3-Z3-RP4-T4					
Turf	309	373	367	355	312	336	300	263	159	122	53	321	299	298	3867	276.21	96.41	25.77	0.12
OTHER LIVE																			1.01
Ascidian	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.07	0.27	0.07	0.30
Eudistoma sp	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2	0.14	0.36	0.10	0.37
Other	0	0	0	0	0	1	0	1	0	0	0	0	1	0	3	0.21	0.43	0.11	0.35
DEAD CORAL WITH ALGAE																			0.00
Dead coral with algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dead gorgonian	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																			0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																			0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																			0.39
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	42	2	0	2	4	14	1	10	64	26	25	25	61	47	323	23.07	22.51	6.02	0.27
Sand	129	96	50	44	117	126	42	57	233	349	439	148	109	139	2078	148.43	117.13	31.30	0.13
UNKNOWNS																			0.00
Unknown	5	3	6	1	0	0	0	0	2	0	0	7	3	1	28	2.00	2.45	0.65	0.00
TAPE, WAND, SHADOW																			0.71
Shadow	7	3	0	4	0	0	0	0	6	1	2	9	10	11	53	3.79	4.08	1.09	0.17
Tape	16	6	14	10	16	14	19	10	13	9	20	16	7	6	176	12.57	4.64	1.24	0.32
Wand	36	46	42	58	64	57	51	52	44	37	37	38	52	51	665	47.50	8.88	2.37	0.22
NOTES (occurring in transect)															**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																			
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**0.86**	**0.82**	**0.91**	**0.74**	**1.14**	**0.98**	**0.75**	**0.72**	**1.07**	**0.62**	**0.47**	**0.93**	**1.02**	**0.96**					
CORAL	0.04	0.03	0.08	0.05	0.12	0.04	0.08	0.06	0.01	0.04	0.03	0.05	0.05	0.04	**0.72**				
GORGONIANS	0.04	0.03	0.21	0.12	0.18	0.14	0.09	0.12	0.22	0.00	0.04	0.02	0.08	0.01					
SPONGES	0.09	0.18	0.14	0.17	0.19	0.15	0.20	0.10	0.12	0.02	0.01	0.14	0.17	0.20					
ZOANTHIDS	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00					
ALGAE	0.28	0.22	0.22	0.17	0.31	0.29	0.18	0.18	0.36	0.34	0.23	0.30	0.32	0.32					
OTHER LIVE	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01					
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.36	0.30	0.21	0.21	0.33	0.35	0.20	0.26	0.32	0.22	0.12	0.37	0.37	0.37					
UNKNOWNS	0.04	0.03	0.05	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.06	0.03	0.01					
TAPE, WAND, SHADOW																			

Project: Dial Cordy Port Everglades

Dataset name:

Location: Reef 3 Previously Impacted Zone 1

File/sheetname: M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\Reef\Impact Zone 1.xls;Data summary

TRANSECT NAME	RI-Z1-RP1-T1	RI-Z1-RP1-T2	RI-Z1-RP1-T3	RI-Z1-RP1-T4	RI-Z1-RP2-T1	RI-Z1-RP2-T2	RI-Z1-RP2-T3	RI-Z1-RP2-T4	RI-Z1-RP3-T1	RI-Z1-RP3-T2	RI-Z1-RP3-T3	RI-Z1-RP3-T4			
Number of frames	23	21	24	20	19	20	20	21	17	20	20	22			
Total points	621	630	720	600	595	600	600	602	585	600	600	610			
Total points (minus tape+wand+shadow)	550	547	630	522	547	536	548	552	533	559	547	556			
MAJOR CATEGORY (% of transect)													**MEAN**	**STD. DEV.**	**STD. ERROR**
CORAL	0.18	0.00	1.11	0.57	0.73	0.19	0.18	0.18	0.19	1.07	0.00	0.18	0.38	0.39	0.11
GORGONIANS	0.00	0.00	0.16	0.96	0.18	0.00	0.00	0.00	0.00	0.72	0.18	0.00	0.18	0.32	0.09
SPONGES	0.55	1.28	1.75	2.49	5.12	2.43	4.38	4.89	8.82	3.58	2.38	1.08	3.23	2.31	0.67
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALGAE	56.91	72.21	70.16	68.58	68.01	46.64	64.96	70.29	67.17	57.25	46.80	34.89	60.32	11.95	3.45
OTHER LIVE	0.18	0.00	0.32	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.14	0.04
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.02
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	42.18	26.51	26.51	26.82	25.78	50.00	29.93	23.55	22.89	36.49	49.73	62.95	35.28	13.06	3.77
UNKNOWNS	0.00	0.00	0.00	0.00	0.18	0.75	0.55	1.09	0.94	0.89	0.91	0.90	0.52	0.45	0.13
TAPE, WAND, SHADOW	11.43	13.17	12.50	13.00	8.07	10.67	8.67	8.31	8.89	6.83	8.83	8.85	9.94	2.13	0.62
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00			
SUBCATEGORIES (% of transect)													**MEAN**	**STD. DEV.**	**STD. ERROR**
CORAL															
Agaricia agaricites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colpophyllia natans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coral (general)	0.00	0.00	0.00	0.00	0.18	0.19	0.00	0.00	0.00	0.00	0.00	0.18	0.05	0.08	0.02
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Meandrina meandrites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Millipora alcicornis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.00	0.00	0.04	0.15	0.04
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montastraea cavernosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.02	0.05	0.02
Montastrea faveolata	0.00	0.00	0.63	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.24	0.07
Montastrea franksi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Porites astreoides	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.54	0.00	0.00	0.06	0.16	0.05
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea siderea	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.02
Solenastrea bournoni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stephanocoenia intersepta	0.18	0.00	0.48	0.00	0.37	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.10	0.17	0.05
GORGONIANS															
Gorgonian	0.00	0.00	0.16	0.96	0.18	0.00	0.00	0.00	0.00	0.72	0.18	0.00	0.18	0.32	0.09
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPONGES															
Agelas clathrodes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthosigmella varians	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.02
Aplysina sp.	0.00	0.18	0.32	0.38	0.55	0.00	0.18	0.00	0.19	0.00	0.00	0.00	0.15	0.19	0.05
Callyspongia vaginalis	0.00	0.00	0.16	0.57	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.09	0.19	0.05
Cliona delitrix	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.17	0.05
Holopsamma helwigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iotrochota birotulata	0.36	0.00	0.48	0.00	0.55	0.19	1.28	1.99	0.94	0.54	0.91	0.54	0.65	0.57	0.16
Ircinia strobilina	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.36	0.38	0.00	0.00	0.00	0.08	0.15	0.04
Monanchora unguifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.03	0.10	0.03

TRANSECT NAME	RI-Z1-RP1-T1	RI-Z1-RP1-T2	RI-Z1-RP1-T3	RI-Z1-RP1-T4	RI-Z1-RP2-T1	RI-Z1-RP2-T2	RI-Z1-RP2-T3	RI-Z1-RP2-T4	RI-Z1-RP3-T1	RI-Z1-RP3-T2	RI-Z1-RP3-T3	RI-Z1-RP3-T4					
Niphates digitalis	0.00	0.00	0.00	0.19	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00		0.03	0.07	0.02	
Pseudoceratina crassa	0.00	0.00	0.63	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00		0.08	0.20	0.06	
Sphecíospongia vesparium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Sponge	0.18	0.00	0.00	0.00	3.66	1.87	2.19	1.63	4.13	2.33	1.46	0.18		1.47	1.45	0.42	
Strongylacidon sp.	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.06	0.02	
Xestospongia sp.	0.00	1.10	0.16	0.19	0.37	0.00	0.18	0.91	3.19	0.72	0.00	0.00		0.57	0.91	0.26	
ZOANTHIDS																	
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE														7.73			
Dictyota	1.64	28.34	20.16	12.26	0.00	0.00	0.00	0.00	2.25	0.36	0.00	0.36		5.45	9.59	2.77	
Halimeda	0.00	0.00	0.00	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.10	0.33	0.10	
Lyngbya sp.	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.05	0.16	0.05	
Macroalgae	20.91	0.00	0.00	0.00	0.00	0.00	1.64	1.09	0.75	1.07	0.18	0.00		2.14	5.94	1.71	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	33.82	43.88	50.00	55.17	68.01	46.64	63.32	69.20	64.17	55.81	46.62	34.53		52.60	12.11	3.49	
OTHER LIVE														0.07			
Ascidian	0.00	0.00	0.32	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.06	0.14	0.04	
Eudistoma sp	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.05	0.02	
Total Ascidian	0.18	0.00	0.32	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		**0.07**	**0.14**	**0.04**	
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DEAD CORAL WITH ALGAE																	
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Dead gorgonian	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.06	0.02	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																	
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																	
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																	
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	42.18	25.96	26.51	26.25	5.67	14.93	8.21	10.87	5.44	17.71	8.04	13.31		17.09	11.14	3.22	
Sand	0.00	0.55	0.00	0.57	20.11	35.07	21.72	12.68	17.45	18.78	41.68	49.64		18.19	16.94	4.89	
UNKNOWNS																	
Unknown	0.00	0.00	0.00	0.00	0.18	0.75	0.55	1.09	0.94	0.89	0.91	0.90		0.52	0.45	0.13	
TAPE, WAND, SHADOW																	
Shadow	0.00	0.00	0.00	0.00	0.55	1.12	0.55	1.09	3.00	1.43	2.74	1.08		0.96	1.03	0.30	
Tape	3.09	2.74	2.38	1.53	2.19	2.99	2.92	1.63	1.69	1.97	1.46	1.80		2.20	0.61	0.18	
Wand	9.82	12.43	11.90	13.41	6.03	7.84	6.02	6.34	5.07	3.94	5.48	6.83		7.93	3.17	0.92	
NOTES (% of transect)														MEAN	STD. DEV.	STD. ERROR	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)													SUMS	MEAN	STD. DEV.	STD. ERROR	SW INDEX
CORAL	1	0	7	3	4	1	1	1	1	6	0	1	26	2.17	2.33	0.67	1.74
GORGONIANS	0	0	1	5	1	0	0	0	0	4	1	0	12	1.00	1.71	0.49	0.00
SPONGES	3	7	11	13	28	13	24	27	47	20	13	6	212	17.67	12.34	3.56	1.62
ZOANTHIDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE	313	395	442	358	372	250	356	388	358	320	256	194	4002	333.50	70.55	20.37	0.47
OTHER LIVE	1	0	2	2	0	0	0	0	0	0	0	0	5	0.42	0.79	0.23	0.50
DEAD CORAL WITH ALGAE	0	0	0	1	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.00
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	RI-Z1-RP1-T1	RI-Z1-RP1-T2	RI-Z1-RP1-T3	RI-Z1-RP1-T4	RI-Z1-RP2-T1	RI-Z1-RP2-T2	RI-Z1-RP2-T3	RI-Z1-RP2-T4	RI-Z1-RP3-T1	RI-Z1-RP3-T2	RI-Z1-RP3-T3	RI-Z1-RP3-T4					
SAND, PAVEMENT, RUBBLE	232	145	167	140	141	268	164	130	122	204	272	350	2335	194.58	71.65	20.68	0.69
UNKNOWNS	0	0	0	0	1	4	3	6	5	5	5	5	34	2.83	2.44	0.71	0.00
TAPE, WAND, SHADOW	71	83	90	78	48	64	52	50	52	41	53	54	736	61.33	15.63	4.51	0.77
TOTAL TRANSECT POINTS	**621**	**630**	**720**	**600**	**595**	**600**	**600**	**602**	**585**	**600**	**600**	**610**	**7363**				
SUBCATEGORIES (occurring in transect)													**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL																	1.74
Agaricia agaricites	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Coral (general)	0	0	0	0	1	1	0	0	0	0	0	1	3	0.25	0.45	0.13	0.25
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Millipora alcicornis	0	0	0	0	0	0	0	0	0	3	0	0	3	0.25	0.87	0.25	0.25
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea cavernosa	0	0	0	0	0	0	0	0	1	0	0	0	1	0.08	0.29	0.08	0.13
Montastrea faveolata	0	0	4	3	0	0	0	0	0	0	0	0	7	0.58	1.38	0.40	0.35
Montastrea franksi	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	0	0	0	0	1	0	0	0	0	3	0	0	4	0.33	0.89	0.26	0.29
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea siderea	0	0	0	0	0	0	1	0	0	0	0	0	1	0.08	0.29	0.08	0.13
Solenastrea bournoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Stephanocoenia intersepta	1	0	3	0	2	0	0	1	0	0	0	0	7	0.58	1.00	0.29	0.35
GORGONIANS																	0.00
Gorgonian	0	0	1	5	1	0	0	0	0	4	1	0	12	1.00	1.71	0.49	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																	1.62
Agelas clathrodes	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Anthosigmella varians	0	0	0	1	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.03
Aplysina sp.	0	1	2	2	3	0	1	0	1	0	0	0	10	0.83	1.03	0.30	0.14
Callyspongia vaginalis	0	0	1	3	0	0	2	0	0	0	0	0	6	0.50	1.00	0.29	0.10
Cliona delitrix	0	0	0	3	0	0	0	0	0	0	0	0	3	0.25	0.87	0.25	0.06
Holopsamma helwigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Iotrochota birotulata	2	0	3	0	3	1	7	11	5	3	5	3	43	3.58	3.12	0.90	0.32
Ircinia strobilina	0	0	0	1	0	0	0	2	2	0	0	0	5	0.42	0.79	0.23	0.09
Monanchora unguifera	0	0	0	0	0	0	0	0	0	0	0	2	2	0.17	0.58	0.17	0.04
Niphates digitalis	0	0	0	1	0	0	1	0	0	0	0	0	2	0.17	0.39	0.11	0.04
Pseudoceratina crassa	0	0	4	0	0	2	0	0	0	0	0	0	6	0.50	1.24	0.36	0.10
Spheciospongia vesparium	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Sponge	1	0	0	0	20	10	12	9	22	13	8	1	96	8.00	7.84	2.26	0.36
Strongylacidon sp.	0	0	0	1	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.03
Xestospongia sp.	0	6	1	1	2	0	1	5	17	4	0	0	37	3.08	4.85	1.40	0.30
ZOANTHIDS																	0.00
Palythoa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																	0.47
Dictyota	9	155	127	64	0	0	0	0	12	2	0	2	371	30.92	54.78	15.81	0.22
Halimeda	0	0	0	6	0	0	0	0	0	0	0	0	6	0.50	1.73	0.50	0.01
Lyngbya sp.	3	0	0	0	0	0	0	0	0	0	0	0	3	0.25	0.87	0.25	0.01
Macroalgae	115	0	0	0	0	0	9	6	4	6	1	0	141	11.75	32.67	9.43	0.12
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Turf	186	240	315	288	372	250	347	382	342	312	255	192	3481	290.08	66.06	19.07	0.12
OTHER LIVE																	0.50
Ascidian	0	0	2	2	0	0	0	0	0	0	0	0	4	0.33	0.78	0.22	0.18

TRANSECT NAME	RI-Z1-RP1-T1	RI-Z1-RP1-T2	RI-Z1-RP1-T3	RI-Z1-RP1-T4	RI-Z1-RP2-T1	RI-Z1-RP2-T2	RI-Z1-RP2-T3	RI-Z1-RP2-T4	RI-Z1-RP3-T1	RI-Z1-RP3-T2	RI-Z1-RP3-T3	RI-Z1-RP3-T4					
Eudistoma sp	1	0	0	0	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.32
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DEAD CORAL WITH ALGAE																	0.00
Dead coral with algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dead gorgonian	0	0	0	1	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.00
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																	0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																	0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																	0.69
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	232	142	167	137	31	80	45	60	29	99	44	74	1140	95.00	62.80	18.13	0.35
Sand	0	3	0	3	110	188	119	70	93	105	228	276	1195	99.58	93.11	26.88	0.34
UNKNOWNS																	0.00
Unknown	0	0	0	0	1	4	3	6	5	5	5	5	34	2.83	2.44	0.71	0.00
TAPE, WAND, SHADOW																	0.77
Shadow	0	0	0	0	3	6	3	6	16	8	15	6	63	5.25	5.56	1.61	0.21
Tape	17	15	15	8	12	16	16	9	9	11	8	10	146	12.17	3.43	0.99	0.32
Wand	54	68	75	70	33	42	33	35	27	22	30	38	527	43.92	18.20	5.25	0.24
NOTES (occurring in transect)													**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**0.74**	**0.64**	**0.75**	**0.81**	**0.82**	**0.84**	**0.82**	**0.80**	**0.87**	**0.93**	**0.85**	**0.76**					
CORAL	0.01	0.00	0.05	0.03	0.04	0.01	0.01	0.01	0.01	0.05	0.00	0.01	**0.23**				
GORGONIANS	0.00	0.00	0.01	0.04	0.01	0.00	0.00	0.00	0.00	0.04	0.01	0.00					
SPONGES	0.03	0.06	0.07	0.09	0.15	0.09	0.14	0.15	0.21	0.12	0.09	0.05					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
ALGAE	0.32	0.24	0.25	0.26	0.26	0.36	0.28	0.25	0.27	0.32	0.36	0.37					
OTHER LIVE	0.01	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DEAD CORAL WITH ALGAE	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.36	0.35	0.35	0.35	0.35	0.35	0.36	0.34	0.34	0.37	0.35	0.29					
UNKNOWNS	0.00	0.00	0.00	0.00	0.01	0.04	0.03	0.05	0.04	0.04	0.04	0.04					
TAPE, WAND, SHADOW																	

Project: Dial Cordy Port Everglades

Dataset name

Location: Reef 3 Previously Impacted Zone 2

File/sheetname: M:\ENV\COMMON\Ecological\Dial Cordy\Video Analysis\ReefImpact Zone 2.xls:Data summary

TRANSECT NAME	RI-Z2-RP1-T1	RI-Z2-RP1-T2	RI-Z2-RP1-T3	RI-Z2-RP1-T4	RI-Z2-RP2-T1	RI-Z2-RP2-T2	RI-Z2-RP2-T3	RI-Z2-RP2-T4	RI-Z2-RP3-T1	RI-Z2-RP3-T2	RI-Z2-RP3-T3	RI-Z2-RP3-T4			
Number of frames	22	20	22	21	21	20	20	23	23	23	21	22			
Total points	616	600	616	630	609	600	600	690	615	622	605	610			
Total points (minus tape+wand+shadow)	540	542	556	558	530	525	519	616	571	575	577	586			
MAJOR CATEGORY (% of transect)													MEAN	STD. DEV.	STD. ERROR
CORAL	0.19	0.55	1.44	0.36	0.19	0.76	0.00	0.97	0.18	0.52	0.00	0.34	0.46	0.43	0.12
GORGONIANS	2.22	0.00	0.00	0.00	0.57	0.00	0.39	1.14	0.00	0.00	0.35	0.68	0.44	0.67	0.19
SPONGES	3.89	1.11	3.78	4.66	0.19	1.90	3.47	0.49	1.75	2.61	1.04	2.39	2.27	1.44	0.42
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALGAE	46.67	48.71	33.81	42.11	53.21	69.33	51.83	34.42	55.34	38.00	40.73	53.58	47.15	10.41	3.01
OTHER LIVE	0.00	0.18	0.18	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.10	0.18	0.05
DEAD CORAL WITH ALGAE	0.19	0.18	0.00	0.00	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.49	0.14
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	46.85	49.26	60.79	52.33	45.85	26.29	44.32	62.99	42.56	60.70	57.89	42.66	49.37	10.42	3.01
UNKNOWNS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.17	0.00	0.00	0.03	0.07	0.02
TAPE, WAND, SHADOW	12.34	9.67	9.74	11.43	12.97	12.50	13.50	10.72	7.15	7.56	4.63	3.93	9.68	3.22	0.93
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00			
SUBCATEGORIES (% of transect)													MEAN	STD. DEV.	STD. ERROR
CORAL													0.44		
Agaricia agaricites	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.11	0.03
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colpophyllia natans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coral (general)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.10	0.28	0.08
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.22	0.06
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Meandrina meandrites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Millipora alcicornis	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.02
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montastraea cavernosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.04	0.15	0.04
Montastrea faveolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montastrea franksi	0.00	0.00	1.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.42	0.12
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Porites astreoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.01	0.05	0.01
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea siderea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.17	0.03	0.07	0.02
Solenastrea bournoni	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.02
Stephanocoenia intersepta	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10	0.03
GORGONIANS															
Gorgonian	2.22	0.00	0.00	0.00	0.57	0.00	0.39	1.14	0.00	0.00	0.35	0.68	0.44	0.67	0.19
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPONGES															
Agelas clathrodes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthosigmella varians	0.00	0.00	0.00	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.16	0.04
Aplysina sp.	0.56	0.37	1.62	1.43	0.00	0.57	0.39	0.00	0.00	0.00	0.00	0.00	0.41	0.57	0.16
Callyspongia vaginalis	0.00	0.00	0.00	1.43	0.00	0.00	0.19	0.00	0.00	0.87	0.00	0.00	0.21	0.46	0.13
Cliona delitrix	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.27	0.08
Holopsamma helwigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iotrochota birotulata	1.11	0.55	1.44	1.08	0.19	0.00	0.00	0.00	1.23	0.17	0.00	0.00	0.48	0.57	0.16

TRANSECT NAME	RI-Z2-RP1-T1	RI-Z2-RP1-T2	RI-Z2-RP1-T3	RI-Z2-RP1-T4	RI-Z2-RP2-T1	RI-Z2-RP2-T2	RI-Z2-RP2-T3	RI-Z2-RP2-T4	RI-Z2-RP3-T1	RI-Z2-RP3-T2	RI-Z2-RP3-T3	RI-Z2-RP3-T4					
Ircinia strobilina	0.56	0.00	0.00	0.00	0.00	0.19	0.58	0.00	0.00	0.00	0.00	0.00		0.11	0.22	0.06	
Monanchora unguifera	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.05	0.02	
Niphates digitalis	0.19	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.07	0.02	
Pseudoceratina crassa	0.56	0.18	0.18	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00		0.12	0.20	0.06	
Spheciospongia vesparium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Sponge	0.74	0.00	0.18	0.00	0.00	0.19	0.00	0.00	0.53	0.52	1.04	1.19		0.37	0.43	0.13	
Strongylacidon sp.	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.10	0.03	
Xestospongia sp.	0.00	0.00	0.00	0.00	0.00	0.00	2.31	0.00	0.00	1.04	0.00	1.19		0.38	0.75	0.22	
ZOANTHIDS																	
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE														**4.39**	**6.32**	**1.82**	
Dictyota	6.11	6.09	1.98	3.58	0.94	5.90	3.28	0.00	0.00	0.00	0.00	0.00		2.32	2.57	0.74	
Halimeda	0.93	2.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.25	0.62	0.18	
Lyngbya sp.	0.00	0.00	0.00	0.00	2.26	4.76	0.19	0.00	0.00	0.00	0.00	0.34		0.63	1.45	0.42	
Macroalgae	2.41	0.00	0.00	0.00	0.00	0.00	1.18	2.44	0.00	0.00	3.84	4.61		1.19	1.67	0.48	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	37.22	40.59	31.83	38.53	50.00	58.67	47.21	31.98	55.34	36.00	37.09	48.63		**42.76**	8.97	**2.59**	
OTHER LIVE														0.10	0.23	0.07	
Ascidian	0.00	0.00	0.18	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34		0.09	0.18	0.05	
Eudistoma sp	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.05	0.02	
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DEAD CORAL WITH ALGAE																	
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Dead gorgonian	0.19	0.18	0.00	0.00	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.00		0.17	0.49	0.14	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																	
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																	
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																	
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	45.93	46.49	60.79	49.62	30.75	22.86	42.77	62.18	7.88	5.57	2.95	1.88		31.66	22.75	6.57	
Sand	0.93	2.77	0.00	2.51	15.09	3.43	1.54	0.81	34.68	55.13	54.94	40.78		17.72	22.19	6.40	
UNKNOWNS																	
Unknown	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.17	0.00	0.00		0.03	0.07	0.02	
TAPE, WAND, SHADOW																	
Shadow	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.53	0.35	0.52	0.68		0.19	0.26	0.07	
Tape	1.67	0.74	1.08	2.51	4.91	2.48	2.89	1.46	2.80	2.26	1.56	1.02		2.11	1.14	0.33	
Wand	12.41	9.96	9.71	10.39	9.81	11.81	12.72	10.55	4.38	5.57	2.77	2.39		8.54	3.73	1.08	
NOTES (% of transect)														**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.05	0.02	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17		0.01	0.05	0.01	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00		4.17	14.43	4.17	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)													**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL	1	3	8	2	1	4	0	6	1	3	0	2	31	2.58	2.43	0.70	2.04
GORGONIANS	12	0	0	0	3	0	2	7	0	0	2	4	30	2.50	3.71	1.07	0.00
SPONGES	21	6	21	26	1	10	18	3	10	15	6	14	151	12.58	7.89	2.28	2.09
ZOANTHIDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE	252	264	188	235	282	364	289	212	316	207	235	314	3138	261.50	51.37	14.83	0.41
OTHER LIVE	0	1	1	3	0	0	0	0	0	0	0	2	7	0.58	1.00	0.29	0.41

TRANSECT NAME	RI-Z2-RP1-T1	RI-Z2-RP1-T2	RI-Z2-RP1-T3	RI-Z2-RP1-T4	RI-Z2-RP2-T1	RI-Z2-RP2-T2	RI-Z2-RP2-T3	RI-Z2-RP2-T4	RI-Z2-RP3-T1	RI-Z2-RP3-T2	RI-Z2-RP3-T3	RI-Z2-RP3-T4					
DEAD CORAL WITH ALGAE	1	1	0	0	0	9	0	0	0	0	0	0	11	0.92	2.57	0.74	0.00
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	253	267	336	292	243	138	230	388	243	349	334	250	3325	277.08	67.38	19.45	0.66
UNKNOWNS	0	0	0	0	0	0	0	0	1	1	0	0	2	0.17	0.39	0.11	0.00
TAPE, WAND, SHADOW	76	58	60	72	79	75	81	74	44	47	28	24	718	59.83	19.94	5.75	0.58
TOTAL TRANSECT POINTS	**616**	**600**	**616**	**630**	**609**	**600**	**600**	**690**	**615**	**622**	**605**	**610**	**7413**				
SUBCATEGORIES (occurring in transect)													**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL																	2.04
Agaricia agaricites	0	2	0	0	0	0	0	0	0	0	0	0	2	0.17	0.58	0.17	0.18
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Coral (general)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	1	0	0	0	0	0	6	0	0	0	0	7	0.58	1.73	0.50	0.34
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	0	4	0	0	0	0	0	0	4	0.33	1.15	0.33	0.26
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Millipora alcicornis	0	0	0	0	1	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.11
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea cavernosa	0	0	0	0	0	0	0	0	0	3	0	0	3	0.25	0.87	0.25	0.23
Montastrea faveolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastrea franksi	0	0	8	0	0	0	0	0	0	0	0	0	8	0.67	2.31	0.67	0.35
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	0	0	0	0	0	0	0	0	0	0	0	1	1	0.08	0.29	0.08	0.11
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea siderea	0	0	0	0	0	0	0	0	1	0	0	1	2	0.17	0.39	0.11	0.18
Solenastrea bournoni	1	0	0	0	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.11
Stephanocoenia intersepta	0	0	0	2	0	0	0	0	0	0	0	0	2	0.17	0.58	0.17	0.18
GORGONIANS																	0.00
Gorgonian	12	0	0	0	3	0	2	7	0	0	2	4	30	2.50	3.71	1.07	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																	2.09
Agelas clathrodes	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Anthosigmella varians	0	0	0	3	0	0	0	0	0	0	0	0	3	0.25	0.87	0.25	0.08
Aplysina sp.	3	2	9	8	0	3	2	0	0	0	0	0	27	2.25	3.17	0.91	0.31
Callyspongia vaginalis	0	0	0	8	0	0	1	0	0	5	0	0	14	1.17	2.59	0.75	0.22
Cliona delitrix	0	0	0	0	0	5	0	0	0	0	0	0	5	0.42	1.44	0.42	0.11
Holopsamma helwigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Iotrochota birotulata	6	3	8	6	1	0	0	0	7	1	0	0	32	2.67	3.17	0.92	0.33
Ircinia strobilina	3	0	0	0	0	1	3	0	0	0	0	0	7	0.58	1.16	0.34	0.14
Monanchora unguifera	1	0	0	0	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.03
Niphates digitalis	1	0	0	1	0	0	0	0	0	0	0	0	2	0.17	0.39	0.11	0.06
Pseudoceratina crassa	3	1	1	0	0	0	0	3	0	0	0	0	8	0.67	1.15	0.33	0.18
Spheciospongia vesparium	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Sponge	4	0	1	0	0	1	0	0	3	3	6	7	25	2.08	2.50	0.72	0.30
Strongylacidon sp.	0	0	2	0	0	0	0	0	0	0	0	0	2	0.17	0.58	0.17	0.06
Xestospongia sp.	0	0	0	0	0	0	12	0	0	6	0	7	25	2.08	4.01	1.16	0.30
ZOANTHIDS																	0.00
Palythoa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																	0.41
Dictyota	33	33	11	20	5	31	17	0	0	0	0	0	150	12.50	13.81	3.99	0.15
Halimeda	5	11	0	0	0	0	0	0	0	0	0	0	16	1.33	3.37	0.97	0.03
Lyngbya sp.	0	0	0	0	12	25	1	0	0	0	0	2	40	3.33	7.63	2.20	0.06

TRANSECT NAME	RI-Z2-RP1-T1	RI-Z2-RP1-T2	RI-Z2-RP1-T3	RI-Z2-RP1-T4	RI-Z2-RP2-T1	RI-Z2-RP2-T2	RI-Z2-RP2-T3	RI-Z2-RP2-T4	RI-Z2-RP3-T1	RI-Z2-RP3-T2	RI-Z2-RP3-T3	RI-Z2-RP3-T4					
Macroalgae	13	0	0	0	0	0	6	15	0	0	21	27	82	6.83	9.72	2.81	0.10
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Turf	201	220	177	215	265	308	245	197	316	207	214	285	2850	237.50	45.85	13.24	0.09
OTHER LIVE																	0.41
Ascidian	0	0	1	3	0	0	0	0	0	0	0	2	6	0.50	1.00	0.29	0.13
Eudistoma sp	0	1	0	0	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.28
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DEAD CORAL WITH ALGAE																	0.00
Dead coral with algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dead gorgonian	1	1	0	0	0	9	0	0	0	0	0	0	11	0.92	2.57	0.74	0.00
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																	0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																	0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																	0.66
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	248	252	336	278	163	120	222	383	45	32	17	11	2109	175.75	130.13	37.57	0.29
Sand	5	15	0	14	80	18	8	5	198	317	317	239	1216	101.33	128.40	37.06	0.37
UNKNOWNS																	0.00
Unknown	0	0	0	0	0	0	0	0	1	1	0	0	2	0.17	0.39	0.11	0.00
TAPE, WAND, SHADOW																	0.58
Shadow	0	0	0	0	1	0	0	0	3	2	3	4	13	1.08	1.51	0.43	0.07
Tape	9	4	6	14	26	13	15	9	16	13	9	6	140	11.67	5.94	1.72	0.32
Wand	67	54	54	58	52	62	66	65	25	32	16	14	565	47.08	19.80	5.72	0.19
NOTES (occurring in transect)													SUMS	MEAN	STD. DEV.	STD. ERROR	
Aspergillis	0	1	0	0	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	1	1	0.08	0.29	0.08	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	0	1	1	0.08	0.29	0.08	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**0.95**	**0.80**	**0.87**	**0.89**	**0.75**	**0.79**	**0.84**	**0.78**	**0.78**	**0.80**	**0.75**	**0.86**					
CORAL	0.01	0.03	0.06	0.02	0.01	0.04	0.00	0.05	0.01	0.03	0.00	0.02	**0.27**				
GORGONIANS	0.08	0.00	0.00	0.00	0.03	0.00	0.02	0.05	0.00	0.00	0.02	0.03					
SPONGES	0.13	0.05	0.12	0.14	0.01	0.08	0.12	0.03	0.07	0.10	0.05	0.09					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
ALGAE	0.36	0.35	0.37	0.36	0.34	0.25	0.34	0.37	0.33	0.37	0.37	0.33					
OTHER LIVE	0.00	0.01	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02					
DEAD CORAL WITH ALGAE	0.01	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.36	0.35	0.30	0.34	0.36	0.35	0.36	0.29	0.36	0.30	0.32	0.36					
UNKNOWNS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00					
TAPE, WAND, SHADOW																	

Project: Dial Cordy Port Everglades
Dataset name:
Location: Reef 3 Previously Impacted Zone 3
File/sheetname: C:\Documents and Settings\Owner\Desktop\Dial Cordy\RI-Z3-RP.xls:Data summary

TRANSECT NAME	RI-Z3-RP1-T1	RI-Z3-RP1-T2	RI-Z3-RP1-T3	RI-Z3-RP1-T4	RI-Z3-RP2-T1	RI-Z3-RP2-T2	RI-Z3-RP2-T3	RI-Z3-RP2-T4	RI-Z3-RP3-T1	RI-Z3-RP3-T2	RI-Z3-RP3-T3	RI-Z3-RP3-T4			
Number of frames	22	20	22	21	22	23	21	21	19	20	20	20			
Total points	616	600	616	630	616	621	609	609	595	600	600	600			
Total points (minus tape+wand+shadow)	540	542	556	558	562	556	557	540	533	560	552	545			
MAJOR CATEGORY (% of transect)													MEAN	STD. DEV.	STD. ERROR
CORAL	0.19	0.55	1.44	0.36	3.02	0.72	0.18	0.74	0.94	0.00	0.54	0.37	0.75	0.81	0.23
GORGONIANS	2.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.37	0.25	0.64	0.18
SPONGES	3.89	1.11	3.78	4.66	4.63	1.44	0.72	2.59	4.13	6.25	2.36	1.65	3.10	1.71	0.49
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALGAE	46.67	48.71	33.81	42.11	65.12	40.83	49.19	51.67	68.48	70.71	56.07	81.10	54.46	14.07	4.06
OTHER LIVE	0.00	0.18	0.18	0.54	0.00	0.18	0.00	0.00	0.00	0.89	0.00	0.00	0.16	0.28	0.08
DEAD CORAL WITH ALGAE	0.19	0.18	0.00	0.00	0.18	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.16	0.05
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	46.85	49.26	60.79	52.33	27.05	56.29	49.91	45.00	25.89	21.25	41.12	15.96	40.98	14.75	4.26
UNKNOWNS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.89	0.54	0.55	0.21	0.33	0.09
TAPE, WAND, SHADOW	12.34	9.67	9.74	11.43	8.77	10.47	8.54	11.33	10.42	6.67	8.00	9.17	9.71	1.60	0.46
Sum (excluding tape+shadow+wand)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00			
SUBCATEGORIES (% of transect)													MEAN	STD. DEV.	STD. ERROR
CORAL													0.75		
Agaricia agaricites	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.11	0.03
Agaricia fragilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia grahamae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia humilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agaricia lamarcki	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colpophyllia natans	0.00	0.00	0.00	0.00	1.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.51	0.15
Coral (general)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coral juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0.00	0.18	0.00	0.00	0.18	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.21	0.06
Diploria clivosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Favia fragum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptoseris cucullata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Madracis decactis	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10	0.03
Madracis mirabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manicina areolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Meandrina meandrites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Millipora alcicornis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.02	0.05	0.02
Montastraea annularis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montastraea cavernosa	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.37	0.75	0.00	0.18	0.00	0.15	0.26	0.07
Montastrea faveolata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montastrea franksi	0.00	0.00	1.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.42	0.12
Mycetophyllia aliciae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oculina diffusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Porites astreoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.19	0.00	0.00	0.00	0.03	0.07	0.02
Porites porites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scolymia cubensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea siderea	0.00	0.00	0.00	0.00	0.18	0.00	0.18	0.00	0.00	0.00	0.00	0.18	0.05	0.08	0.02
Solenastrea bournoni	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.02
Stephanocoenia intersepta	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.18	0.08	0.14	0.04
GORGONIANS															
Gorgonian	2.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.37	0.25	0.64	0.18
Pseudopterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pterogorgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPONGES															
Agelas clathrodes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anthosigmella varians	0.00	0.00	0.00	0.54	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.08	0.18	0.05
Aplysina sp.	0.56	0.37	1.62	1.43	0.18	0.36	0.54	0.56	0.00	0.18	0.91	0.00	0.56	0.52	0.15
Callyspongia vaginalis	0.00	0.00	0.90	1.43	0.71	0.00	0.00	0.56	0.19	0.00	0.00	0.18	0.26	0.44	0.13
Cliona delitrix	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Holopsamma helwigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iotrochota birotulata	1.11	0.55	1.44	1.08	0.00	0.18	0.00	0.19	0.00	1.07	0.00	0.37	0.50	0.53	0.15
Ircinia strobilina	0.56	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.18	0.05

TRANSECT NAME	RI-Z3-RP1-T1	RI-Z3-RP1-T2	RI-Z3-RP1-T3	RI-Z3-RP1-T4	RI-Z3-RP2-T1	RI-Z3-RP2-T2	RI-Z3-RP2-T3	RI-Z3-RP2-T4	RI-Z3-RP3-T1	RI-Z3-RP3-T2	RI-Z3-RP3-T3	RI-Z3-RP3-T4					
Monanchora unguifera	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00		0.03	0.07	0.02	
Niphates digitalis	0.19	0.00	0.00	0.18	0.18	0.00	0.00	0.00	0.19	0.18	0.18	0.00		0.09	0.09	0.03	
Pseudoceratina crassa	0.56	0.18	0.18	0.00	2.85	0.54	0.00	0.56	0.00	0.00	0.00	0.00		0.41	0.80	0.23	
Spheciospongia vesparium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Sponge	0.74	0.00	0.18	0.00	0.00	0.00	0.18	0.19	2.44	4.29	1.09	1.10		0.85	1.30	0.38	
Strongylacidon sp.	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03	0.10	0.03	
Xestospongia sp.	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.19	1.31	0.36	0.18	0.00		0.23	0.40	0.12	
ZOANTHIDS																	
Palythoa sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Zoanthid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
ALGAE														8.54			
Dictyota	6.11	6.09	1.98	3.58	1.78	0.18	11.49	3.89	3.94	4.46	2.54	4.59		4.22	2.87	0.83	
Halimeda	0.93	2.03	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.00		0.29	0.62	0.18	
Lyngbya sp.	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.18	0.18	0.37		0.09	0.14	0.04	
Macroalgae	2.41	0.00	0.00	0.00	33.63	1.62	0.00	7.78	1.13	0.36	0.00	0.37		3.94	9.61	2.77	
Sargassum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Turf	37.22	40.59	31.83	38.53	29.36	39.03	37.70	39.44	63.41	65.71	52.36	75.78		45.91	14.83	4.28	
OTHER LIVE														0.15			
Ascidian	0.00	0.00	0.18	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.06	0.16	0.05	
Eudistoma sp	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.00		0.09	0.26	0.07	
Total Ascidian	0.00	0.18	0.18	0.54	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.00		**0.15**	**0.28**	**0.08**	
Other	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00		0.01	0.05	0.01	
DEAD CORAL WITH ALGAE																	
Dead coral with algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Dead gorgonian	0.19	0.18	0.00	0.00	0.18	0.54	0.00	0.00	0.00	0.00	0.00	0.00		0.09	0.16	0.05	
Old dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Recently dead coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
CORALLINE ALGAE																	
Crustose coralline algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
DISEASED CORALS																	
Diseased coral	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
SAND, PAVEMENT, RUBBLE																	
Pavement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Rubble	45.93	46.49	60.79	49.82	27.05	56.29	49.37	44.81	5.44	3.75	4.17	1.28		32.93	23.05	6.65	
Sand	0.93	2.77	0.00	2.51	0.00	0.00	0.54	0.19	20.45	17.50	36.96	14.68		8.04	11.85	3.42	
UNKNOWNS																	
Unknown	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.89	0.54	0.55		0.21	0.33	0.09	
TAPE, WAND, SHADOW																	
Shadow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13	0.36	0.00	0.37		0.15	0.34	0.10	
Tape	1.67	0.74	1.08	2.51	1.60	3.78	1.80	2.78	2.06	1.96	2.54	3.30		2.15	0.88	0.25	
Wand	12.41	9.96	9.71	10.39	8.01	7.81	7.54	10.00	8.44	4.82	6.16	6.42		8.48	2.12	0.61	
NOTES (% of transect)														**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02	0.05	0.02	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00		0.02	0.05	0.02	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
NOTES (% of coral)																	
Aspergillis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Black Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Bleached coral point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33	0.00		2.78	9.62	2.78	
Condensed Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Isolated Fish Biting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Other disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Paling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
White Band Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
Yellow Blotch Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	
MAJOR CATEGORY (occurring in transect)													**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL	1	3	8	2	17	4	1	4	5	0	3	2	50	4.17	4.67	1.35	2.13
GORGONIANS	12	0	0	0	0	0	0	0	0	0	2	2	16	1.33	3.45	0.99	0.00
SPONGES	21	6	21	26	26	8	4	14	22	35	13	9	205	17.08	9.55	2.76	2.00
ZOANTHIDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE	252	264	188	235	366	227	274	279	365	396	304	442	3592	299.33	76.74	22.15	0.57
OTHER LIVE	0	1	1	3	0	1	0	0	0	5	0	0	11	0.92	1.56	0.45	0.92
DEAD CORAL WITH ALGAE	1	1	0	0	1	3	0	0	0	0	0	0	6	0.50	0.90	0.26	0.00

TRANSECT NAME	RI-Z3-RP1-T1	RI-Z3-RP1-T2	RI-Z3-RP1-T3	RI-Z3-RP1-T4	RI-Z3-RP2-T1	RI-Z3-RP2-T2	RI-Z3-RP2-T3	RI-Z3-RP2-T4	RI-Z3-RP3-T1	RI-Z3-RP3-T2	RI-Z3-RP3-T3	RI-Z3-RP3-T4					
CORALLINE ALGAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE	253	267	338	292	152	313	278	243	138	119	227	87	2707	225.58	81.94	23.65	0.49
UNKNOWNS	0	0	0	0	0	0	0	0	3	5	3	3	14	1.17	1.80	0.52	0.00
TAPE, WAND, SHADOW	76	58	60	72	54	65	52	69	62	40	48	55	711	59.25	10.34	2.99	0.57
TOTAL TRANSECT POINTS	**616**	**600**	**616**	**630**	**616**	**621**	**609**	**609**	**595**	**600**	**600**	**600**	**7312**				
SUBCATEGORIES (occurring in transect)													**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	**SW INDEX**
CORAL																	2.13
Agaricia agaricites	0	2	0	0	0	0	0	0	0	0	0	0	2	0.17	0.58	0.17	0.13
Agaricia fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia grahamae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Colpophyllia natans	0	0	0	0	10	0	0	0	0	0	0	0	10	0.83	2.89	0.83	0.32
Coral (general)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Coral juvenile	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dichocoenia stokesi	0	1	0	0	1	4	0	0	0	0	0	0	6	0.50	1.17	0.34	0.25
Diploria clivosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Diploria strigosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Madracis decactis	0	0	0	0	2	0	0	0	0	0	0	0	2	0.17	0.58	0.17	0.13
Madracis mirabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Meandrina meandrites	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Millipora alcicornis	0	0	0	0	0	0	0	1	0	0	0	0	1	0.08	0.29	0.08	0.08
Montastraea annularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastraea cavernosa	0	0	0	0	3	0	0	2	4	0	1	0	10	0.83	1.40	0.41	0.32
Montastrea faveolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Montastrea franksi	0	0	8	0	0	0	0	0	0	0	0	0	8	0.67	2.31	0.67	0.29
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia danaana	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Mycetophyllia lamarckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Oculina diffusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Porites astreoides	0	0	0	0	0	0	0	1	1	0	0	0	2	0.17	0.39	0.11	0.13
Porites porites	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Scolymia cubensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea radians	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Siderastrea siderea	0	0	0	0	1	0	1	0	0	0	0	1	3	0.25	0.45	0.13	0.17
Solenastrea bournoni	1	0	0	0	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	0.08
Stephanocoenia intersepta	0	0	0	2	0	0	0	0	0	0	2	1	5	0.42	0.79	0.23	0.23
GORGONIANS																	0.00
Gorgonian	12	0	0	0	0	0	0	0	0	0	2	2	16	1.33	3.45	0.99	0.00
Pseudopterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Pterogorgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SPONGES																	2.00
Agelas clathrodes	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Anthosigmella varians	0	0	0	3	0	0	0	2	0	0	0	0	5	0.42	1.00	0.29	0.09
Aplysina sp.	3	2	9	8	1	2	3	3	0	1	5	0	37	3.08	2.91	0.84	0.31
Callyspongia vaginalis	0	0	0	8	4	0	0	3	1	0	0	1	17	1.42	2.47	0.71	0.21
Cliona delitrix	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Holopsamma helwigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Iotrochota birotulata	6	3	8	6	0	1	0	1	0	6	0	2	33	2.75	2.96	0.85	0.29
Ircinia strobilina	3	0	0	0	0	2	0	0	0	0	0	0	5	0.42	1.00	0.29	0.09
Monanchora unguifera	1	0	0	0	0	0	0	0	0	1	0	0	2	0.17	0.39	0.11	0.05
Niphates digitalis	1	0	0	1	1	0	0	0	1	1	1	0	6	0.50	0.52	0.15	0.10
Pseudoceratina crassa	3	1	1	0	16	3	0	3	0	0	0	0	27	2.25	4.52	1.30	0.27
Spheciospongia vesparium	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Sponge	4	0	1	0	0	0	1	1	13	24	6	6	56	4.67	7.23	2.09	0.35
Strongylacidon sp.	0	0	2	0	0	0	0	0	0	0	0	0	2	0.17	0.58	0.17	0.05
Xestospongia sp.	0	0	0	0	4	0	0	1	7	2	1	0	15	1.25	2.18	0.63	0.19
ZOANTHIDS																	0.00
Palythoa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Zoanthid	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
ALGAE																	0.57
Dictyota	33	33	11	20	10	1	64	21	21	25	14	25	278	23.17	15.91	4.59	0.20
Halimeda	5	11	0	0	0	0	0	3	0	0	0	0	19	1.58	3.37	0.97	0.03
Lyngbya sp.	0	0	0	0	2	0	0	0	0	1	1	2	6	0.50	0.80	0.23	0.01
Macroalgae	13	0	0	0	189	9	0	42	6	2	0	2	263	21.92	53.95	15.57	0.19
Sargassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00

TRANSECT NAME	RI-Z3-RP1-T1	RI-Z3-RP1-T2	RI-Z3-RP1-T3	RI-Z3-RP1-T4	RI-Z3-RP2-T1	RI-Z3-RP2-T2	RI-Z3-RP2-T3	RI-Z3-RP2-T4	RI-Z3-RP3-T1	RI-Z3-RP3-T2	RI-Z3-RP3-T3	RI-Z3-RP3-T4					
Turf	201	220	177	215	165	217	210	213	338	368	289	413	3026	252.17	80.25	23.17	0.14
OTHER LIVE																	0.92
Ascidian	0	0	1	3	0	0	0	0	0	0	0	0	4	0.33	0.89	0.26	0.37
Eudistoma sp	0	1	0	0	0	0	0	0	0	5	0	0	6	0.50	1.45	0.42	0.33
Other	0	0	0	0	0	1	0	0	0	0	0	0	1	0.08	0.29	0.08	0.22
DEAD CORAL WITH ALGAE																	0.00
Dead coral with algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Dead gorgonian	1	1	0	0	1	3	0	0	0	0	0	0	6	0.50	0.90	0.26	0.00
Old dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Recently dead coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
CORALLINE ALGAE																	0.00
Crustose coralline algae	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
DISEASED CORALS																	0.00
Diseased coral	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
SAND, PAVEMENT, RUBBLE																	0.49
Pavement	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Rubble	248	252	338	278	152	313	275	242	29	21	23	7	2178	181.50	127.33	36.76	0.17
Sand	5	15	0	14	0	0	3	1	109	98	204	80	529	44.08	65.11	18.80	0.32
UNKNOWNS																	0.00
Unknown	0	0	0	0	0	0	0	0	3	5	3	3	14	1.17	1.80	0.52	0.00
TAPE, WAND, SHADOW																	0.57
Shadow	0	0	0	0	0	0	0	0	6	2	0	2	10	0.83	1.80	0.52	0.06
Tape	9	4	6	14	9	21	10	15	11	11	14	18	142	11.83	4.84	1.40	0.32
Wand	67	54	54	58	45	44	42	54	45	27	34	35	559	46.58	11.37	3.28	0.19
NOTES (occurring in transect)													**SUMS**	**MEAN**	**STD. DEV.**	**STD. ERROR**	
Aspergillis	0	1	0	0	0	0	0	0	0	0	0	0	1	0.08	0.29	0.08	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	1	0	1	0.08	0.29	0.08	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
NOTES (occurring in coral)																	
Aspergillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Black Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Bleached coral point	0	0	0	0	0	0	0	0	0	0	1	0	1	0.08	0.29	0.08	
Condensed Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Isolated Fish Biting	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Other disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Paling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Plague, Type II (White Plague, Type II)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
White Band Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Yellow Blotch Disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
Shannon-Weaver Index	**0.95**	**0.80**	**0.87**	**0.89**	**0.89**	**0.83**	**0.74**	**0.83**	**0.81**	**0.83**	**0.86**	**0.60**					
CORAL	0.01	0.03	0.06	0.02	0.11	0.04	0.01	0.04	0.04	0.00	0.03	0.02	**0.40**				
GORGONIANS	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02					
SPONGES	0.13	0.05	0.12	0.14	0.14	0.06	0.04	0.09	0.13	0.17	0.09	0.07					
ZOANTHIDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
ALGAE	0.36	0.35	0.37	0.36	0.28	0.37	0.35	0.34	0.26	0.25	0.33	0.17					
OTHER LIVE	0.00	0.01	0.01	0.03	0.00	0.01	0.00	0.00	0.00	0.04	0.00	0.00					
DEAD CORAL WITH ALGAE	0.01	0.01	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00					
CORALLINE ALGAE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
DISEASED CORALS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SAND, PAVEMENT, RUBBLE	0.36	0.35	0.30	0.34	0.35	0.32	0.35	0.36	0.35	0.33	0.37	0.29					
UNKNOWNS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.03	0.03					
TAPE, WAND, SHADOW																	

Appendix D

D-3

Acropora Survey

Port Everglades Feasibility Study

Acropora Coral Survey

Final Report

October 2010

Prepared for:

Jacksonville District
US Army Corps of Engineers
701 San Marco Blvd.
Jacksonville, FL 32207

Prepared by:
Dial Cordy and Associates Inc.
3620 Tuscany Drive
Hollywood, FL 33021

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1.0 INTRODUCTION

Dial Cordy and Associates Inc. was contracted by the Jacksonville District, Corps of Engineers, under contract W912HN-05-D-0014 Task Order CS10 to survey for acroporid corals in the vicinity of the indirect and direct impact areas for the Port Everglades Feasibility Study. This survey and report was conducted in support of consultation under Section 7 of the Endangered Species Act.

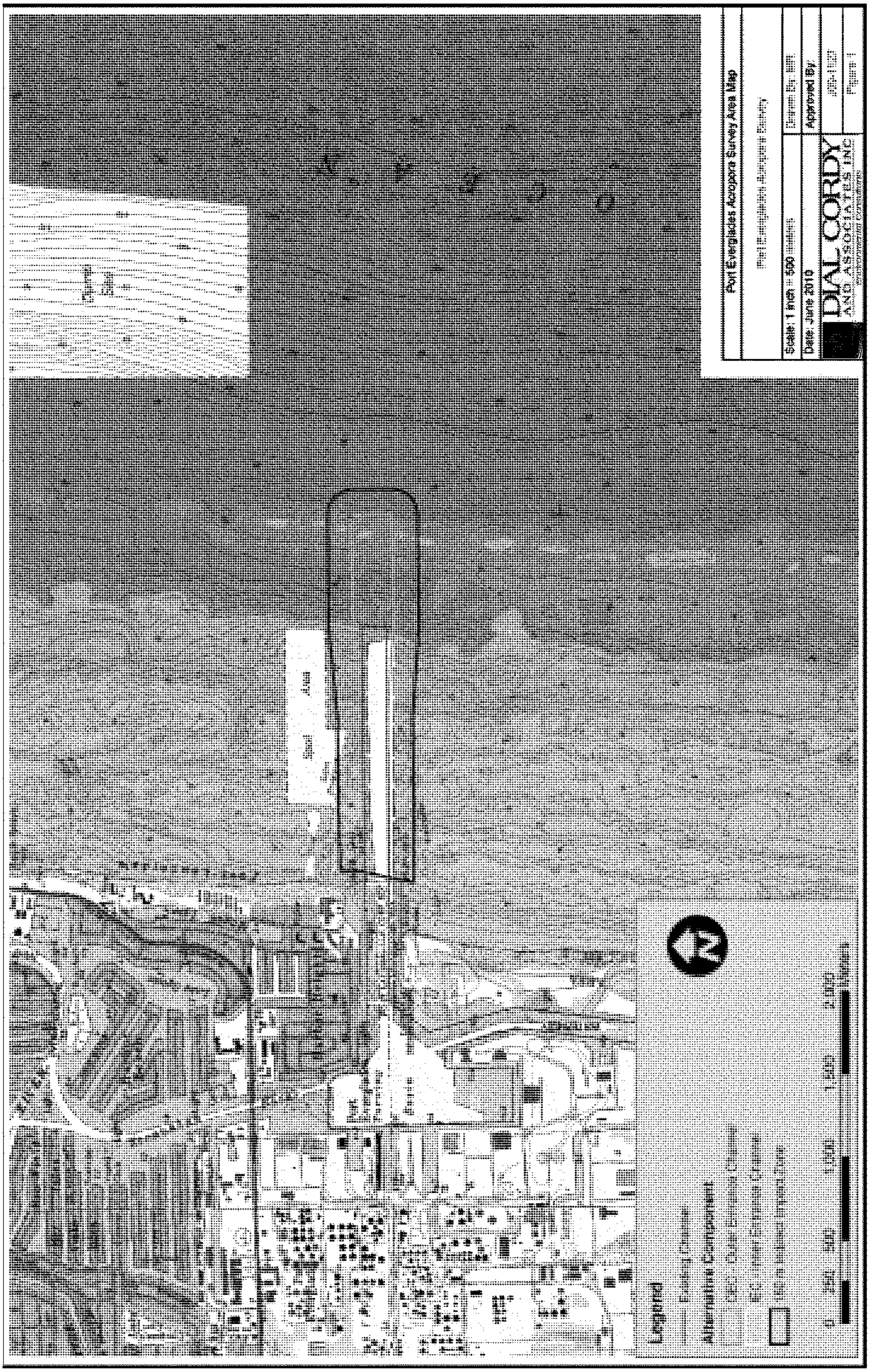
Two scleractinian corals, elkhorn coral *(Acropora palmate)* and staghorn coral (*Acropora cervicornis*), were listed as threatened species under the Endangered Species Act, as amended on 9 May 2006. A critical habitat rule for these two species became effective on 26 December 2008. Four areas within the coastal United States were proposed as critical habitat units, including Florida (3,442 square kilometers), Puerto Rico (3,582 square kilometers), St Thomas/St. John (313 square kilometers), and St. Croix (326 square kilometers, for a total of 7,663 square kilometers). Critical habitat consists of "Primary Constituent Elements", for Acroporid species, this includes "consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover" (Federal Register November 26, 2008), including habitats from mean high water (MHW) to 30m depth.

Port Everglades, Florida is currently planning a deepening and widening of the federal entrance channel, which is one of the 13 federal channels within *Acropora* critical habitat. *Acropora* critical habitat includes the first, second, and third reefs in the vicinity of Port Everglades down to a depth of 30m; although, *Acropora* has not been documented on either the second or third reefs in the Port's vicinity. The Port Everglades' proposed deepening and widening is anticipated to directly impact 15.35 acres and indirectly impact 91.29 acres (150m buffer) of the first, second, and third reefs. *Acropora cervicornis* colonies are known to exist in the vicinity of Port Everglades, 2,780 feet (848m) to the south of the Port entrance channel, on the near shore hardbottom, and 1,400 feet (427m) north on the first reef (this study, NOVA 2008). These locations are outside the indirect impact assessment area for the Port Everglades' expansion project. As of the writing of this document, no colonies of *A. palmata* have been documented within the vicinity of the existing channel. To date, no *A.cervicornis* have been identified within the direct or indirect impact areas within the proposed Project area (Dial Cordy 2009).

The Port Everglades *Acropora* survey area includes the direct and indirect impact areas out to 150m from the existing channel from the jetty to the third reef (Figure 1).

2.0 METHODS

A two-tiered approach was used to assess presence of *acroporid* corals adjacent to the Port Everglades entrance channel. These methods include a integrated towed video survey, follow-up groundtruthing diver surveys, and diver surveys following the NMFS protocol.



Port Everglades Acropora Survey Area Map
Scale: 1 inch = 500
Date: June 2010
Approved By:
DIAL CORDY
AND ASSOCIATES INC
environmental consultants
Legend
Alternative Component

2.1 Integrated Towed Video

Federally maintained navigation channels, within the known range of *Acropora* and the proposed critical habitat, are much larger than 0.25 acres. Federal channels facilitate commercial and recreational vessel traffic, including large shipping freighters, container ships, cruise vessels, and recreational boats. Federal channels have national security issues, and some federal channels serve military installations. In general, federal navigation channels are busy with high vessel traffic transporting goods, people, and services to and from ports, regionally, as well as internationally. Due to the high volume of vessel traffic in federally authorized channels, SCUBA diving can be challenging and, at times, dangerous. Entrance channels are often narrow, allowing minimal width for vessels other than the scheduled commercial and military vessels to pass through the channel. As a result, conducting SCUBA surveys within federal channels should be minimized and only done when necessary.

In order to assess *Acropora* presence and proposed critical habitat over large areas, such as federal channels (>0.25 acre), geospatially referenced qualitative video survey methodology was used, with divers providing additional detailed quantitative data, should either *A.palmata* or *A.cervicornis* be video documented.

Qualitative underwater assessments have been used to characterize benthic habitats over large areas (Miller and Muller 1999). Common methods include diver performed manta tow and more recently underwater towed video (Marcos et al. 2007, Dial Cordy 2001). Qualitative video methods currently in use incorporate geospatial referencing capabilities, which can provide real time geospatial data on the video image (Dial Cordy 2001). This technology allows, with precision and accuracy, staff to return to a particular point on the bottom, using DGPS. This technology is useful in surveying large areas of benthic habitat, where diving may be difficult or dangerous, as in the case of most federal navigation channels. Geo-referenced qualitative video surveys may be used as an initial assessment tool to characterize *Acropora* critical habitat in federal navigation channels, high-traffic areas, and large (>0.25 acre) sites, which are not routinely safe or economical for diving assessments.

The video survey was performed utilizing an integrated towed calibrated video system which records high definition digital video, and is linked to geo-referenced navigational software and a precision positioning system (DGPS) with an accuracy of +/- one-meter. Both a vertical and oblique camera were mounted on the tow fish with digital video recorded and viewed from the surface. Such geo-referenced navigational software programs display the geographical coordinates and video camera depth. These data are seen, in real time, aboard the survey vessel's video screen. The video survey was performed over direct and indirect impact areas (150m beyond direct impact) to adequately cover the site.

Calibration video was recorded in areas of known *Acropora* occurrence, south of Port Everglades, adjacent to Hollywood Beach, near JUL6 (Gilliam et al. 2006). *Acropora cervicornis* colonies were positively identified in the calibration video and morphological characteristics were noted for use in video analysis. Colonies 10cm across were visible up to 2m above the bottom. Above 2m colonies between 10 and 20cm in diameter were visible.

2.1.1 Towed Video Specifications and Coverage:

- Towed video transects were spaced 10m apart and towed 2m to 3m above the substrate, yielding a video record for 40% of the survey area. In total, 65 towed video transects were completed (Figure 2).
  - Minimum detectable coral colony size of 20cm.
  - Oblique and vertical digital images were recorded with position overlays and tow fish depths for post-processing.

2.1.1.1 Acropora Identification from Video

Following the survey, video records were post-processed to visually identify any possible *Acropora* colonies, record their location, and estimate the colony area coverage. Video was visually analyzed by two independent qualified marine biologists for signatures of *Acropora* morphological characteristics:

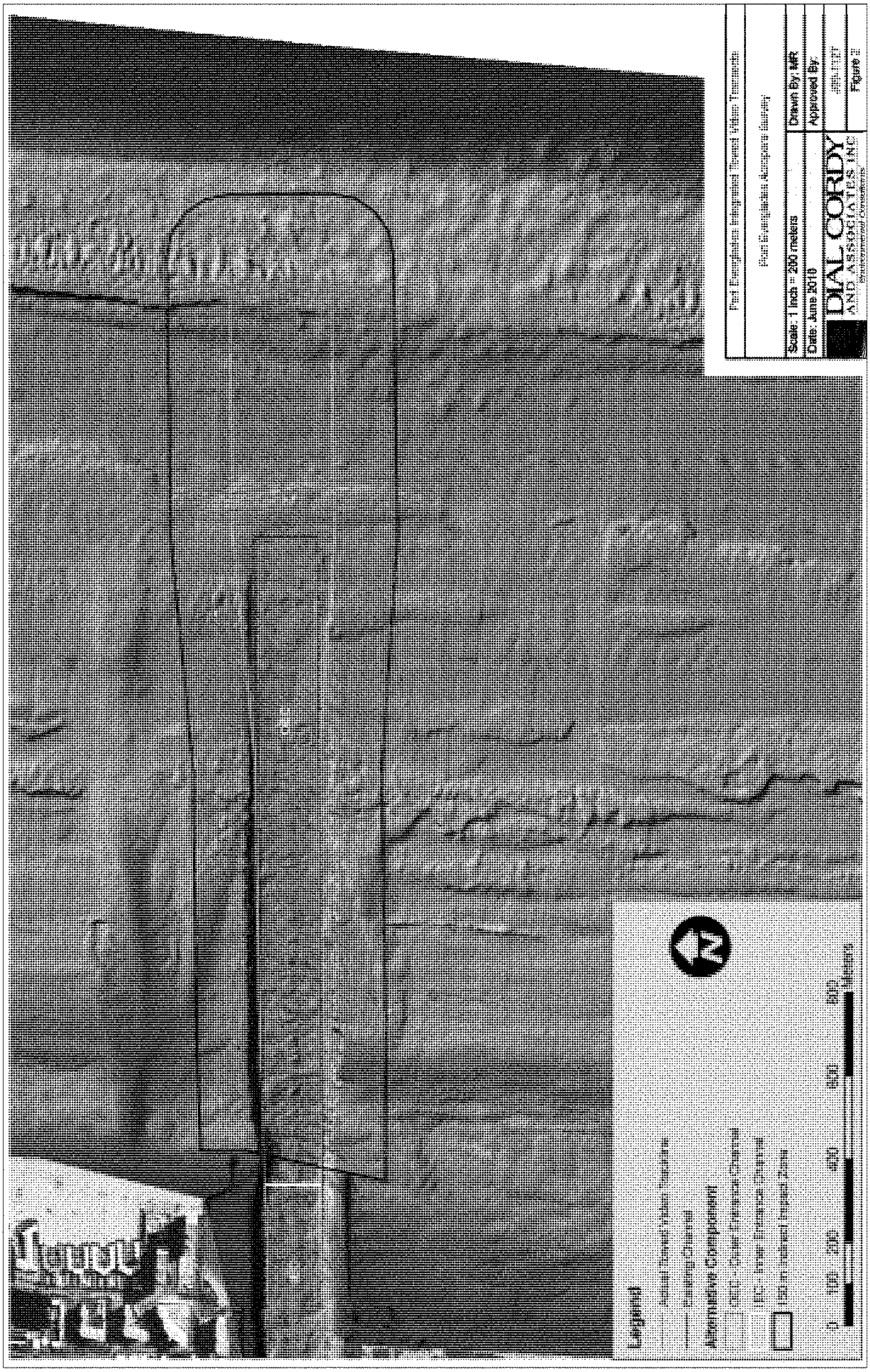
1. Plate (*A.palmata*) or branching morphology (*A.palmata* and *A.cervicornis*)
2. Bouquet appearance – branches radiating from central point (*A.cervicornis*)
3. White tips or edges on colony

Follow-up diver surveys were used to confirm the identity of the organism or organisms identified in the video.

2.1.2 Diver Surveys

2.1.2.1 Video Image Surveys

Post-processed video was groundtruthed by divers at each of 21 locations where potential *Acropora* colonies were identified. A buoy was positioned using the latitude and longitude from the geo-referenced video still-capture. Using the reference still-capture a bounce dive was conducted to verify the identity of the potential acroporid. Once the organism within the reference still-capture was located, a still underwater photograph was taken to document the identity of the potential *Acropora*.


Scale: 1 inch = 200 meters
Date: June 2010
Drawn By: MR
Approved By:
DIAL CORDY
AND ASSOCIATES INC.
Figure
Legend
Alternative Component
0 100 200 400 600 800 Meters

2.2 NMFS Diver Protocol Surveys

Diver surveys were conducted for acroporid corals using the "Recommended Survey Protocol for *Acropora* spp. in Support of Section 7 Consultation – Intermediate to Large Project Areas (>0.1 hectare or 0.25 acre)" (NMFS 2007) in nearshore areas and on the third reef (Figure 3).

Intermediate to Large Project Area (> ~0.1 hectare or ~0.25 acre)
Data were collected at one sampling site per 10,000m^2 of critical habitat, such that 16 individual sites within the survey area were surveyed (Figure 3). Survey sites (10,000m^2) were predetermined using ArcView GIS. Reference points were also predetermined using ArcView GIS and set in the center of the 100m x 100m survey site. This design maximized the distance for diver surveys within a site and kept each origin approximately 100m from the nearest adjacent dive site. A reference point was manually relocated based on habitat maps to maximize the likelyhood to surveying *Acropora* habitat (i.e. avoidance of sand). At each sampling site, a single or two-tiered survey was conducted as follows:

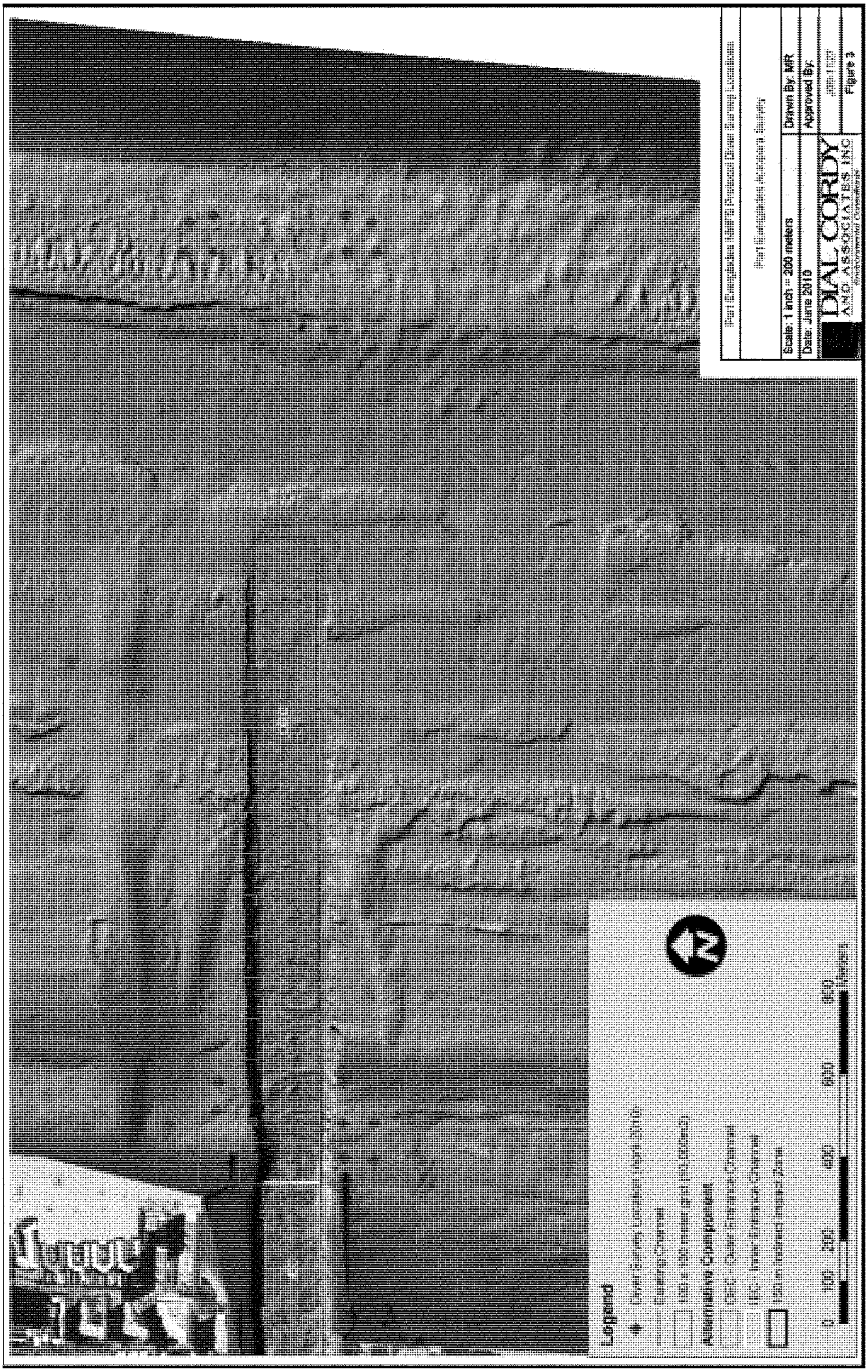
1. First, divers conducted a structured 20-minute timed swim from the referenced center point (i.e., downline). If five or less colonies were encountered, data (see item 2 a-e, below) and photographs were collected on those colonies and divers proceeded to the next sampling site. If more than five colonies were encountered, divers proceeded with additional survey techniques as follows.

2. Divers conducted three belt transects from the referenced center point at three random bearings. Each belt transect measured 4m x 50m, for a total of 200m^2 sampled. All required data were recorded for all colonies encountered along the transects as follows.

    a. Species;
    b. Single largest linear dimension of the colony or length, height, and width (units = mm) ;
    c. Rank of percentage live tissue (i.e., > or < 50%);
    d. GPS coordinate of each colony (if possible) or each survey site (unit = decimal degrees and state datum); and
    e. Site map with locations of each colony.

3.0 RESULTS

More than 56 acres of *Acropora* critical habitat were surveyed using a combination of towed video and diver surveys within the Port Everglades direct and indirect impact areas (150m north and south of the channel), from the nearshore hardbottom out to the third reef (Figure 2). Video was captured for 40% of the bottom surveyed, along 65 transects. Video was reviewed to document potential *Acropora* colonies for follow-up diver surveys. In total, 21 potential colonies were identified within the survey area (Figure 4). These locations were visited by a diver on November 21, 2009.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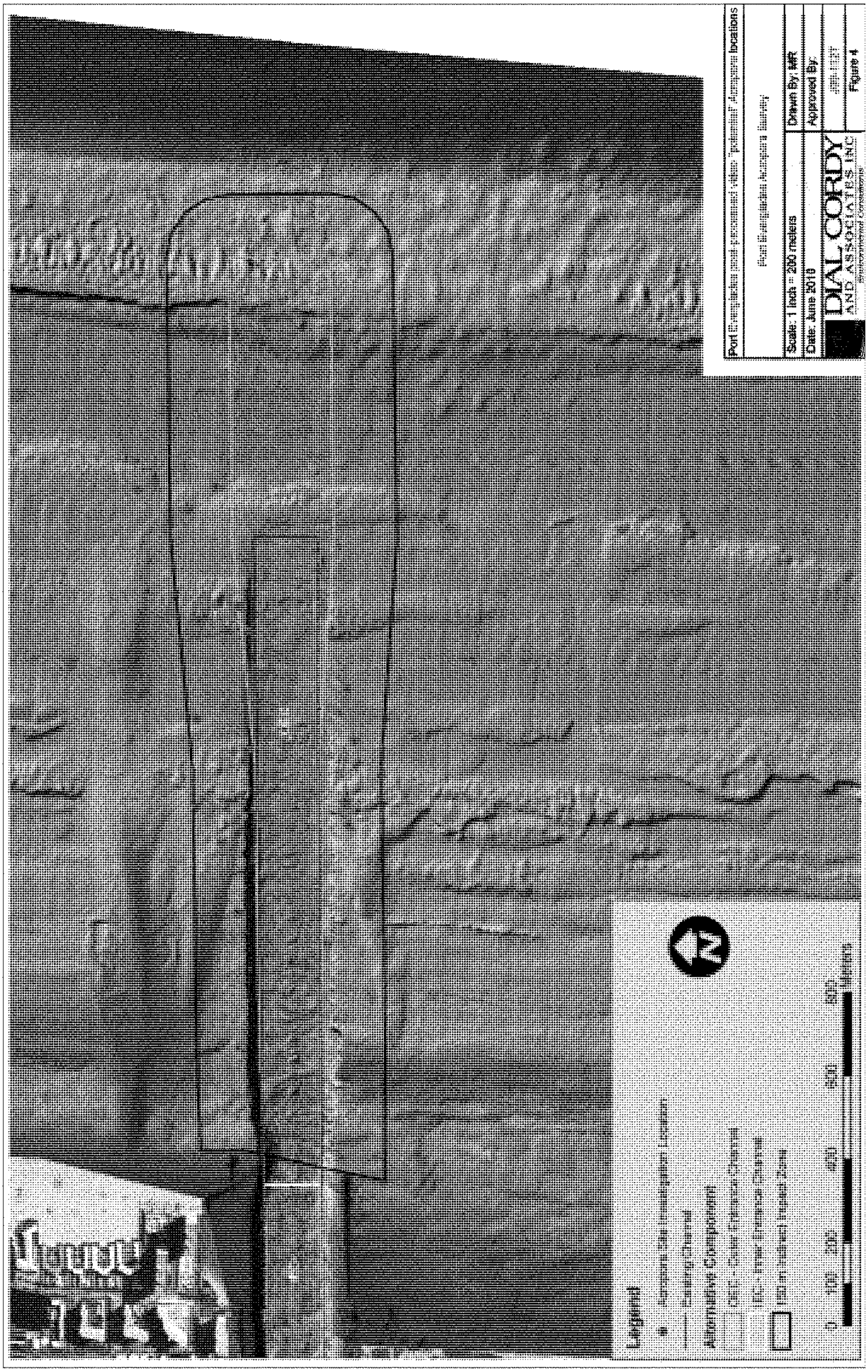
Date: June 2010
Drawn By: MR
Approved By:
DIAL CORDY
AND ASSOCIATES INC
Figure 3
Legend
Alternative Component


Legend
Scale: 1 inch = 200 meters
Date: June 2010
Drawn By: MR
Approved By:
DIAL CORDY
AND ASSOCIATES INC
Environmental Consultants
Figure 4

Diver surveys at 21 potential colony locations documented no *A.cervicornis* or *A.palmata* colonies. These results are similar to results from previous mapping efforts within Broward County and in the vicinity of the Port Everglades entrance channel (Thomas et al 2000; Vargus-Angel et al. 2003; Dial Cordy 2009). Organisms identified as potential Acropora colonies were sponges, octocorals, and the hard coral, *Millepora alcicornis* (Table 1).

Additionally, 8 locations were surveyed using the NMFS 2007 *Acropora* protocol (Figure 3). No *Acropora* colonies were identified during these dives on the outer reef or within the nearshore hardbottom. Dives conducted on the outer reef were in 20-35 m, where the habitat consisted of deep water corals, including black corals.

Table 1 Organisms positively identified during diver surveys that were marked as "potential" *Acropora* colonies from post-processed video.

Organisms Identified at Potential Colony Locations	
Sponges	*Iotrochota birotulata*
	Strongylacidon sp.
	Amphimedon compressa
Hard Coral	*Millepora alcicornis*
Octocoral	*Briareum asbestinum*

4.0 DISCUSSION

Underwater video has been used to assess benthic habitats and fish populations in a wide range of habitat types (Somerton and Glendhill 2005). In areas difficult to sample directly, such as Port Everglades, the geo-referenced integrated towed video was an effective tool for rapidly and safely assessing potential *Acropora* habitat.

Towed video, NMFS diver surveys and video confirmation dives were all completed to assess *Acropora* critical habitat within the Port Everglades survey area. Twenty-one dives were made to identify organisms that were designated as "potential" *Acropora* colonies in post-processed video. No *Acropora* colonies were documented within the direct or indirect impact areas of the Port Everglades expansion area during this survey. Currently, it is presumed that the colonies located 2,780 feet (848m) to the south (this survey) and 1,400 feet (427m) north (NOVA 2008) of the entrance channel are the nearest colonies to the project area.

5.0 LITERATURE CITED

Dial Cordy and Associates Inc. 2007. Port Everglades Reef Mapping and Assessment Report. Prepared for Jacksonville District Corps of Engineers.

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Appendix D

D-4

Seagrass Surveys

Seagrass Mapping and Assessment
Port Everglades Harbor

Final Report

December, 2009

Prepared for:
U.S. Army Corps of Engineers
Jacksonville District
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1.0 INTRODUCTION

Dial Cordy and Associates Inc. (DC&A) was originally subcontracted by Gulf Engineers and Consultants, Inc. (GEC) to conduct an environmental baseline and impact assessment for proposed deepening and widening of Port Everglades, Broward County, FL for the U.S. Army Corps of Engineers, Jacksonville District (Corps), under contract No. DACW17-99-D-0043 in 1999. Data were collected in an initial seagrass survey in 1999 (DC&A 1999). That study included baseline mapping of seagrasses within the project area at Port Everglades and the results are found in DC&A (1999). In 2000 additional survey transects were surveyed and together with 1999 results are presented here and in DC&A (2001).

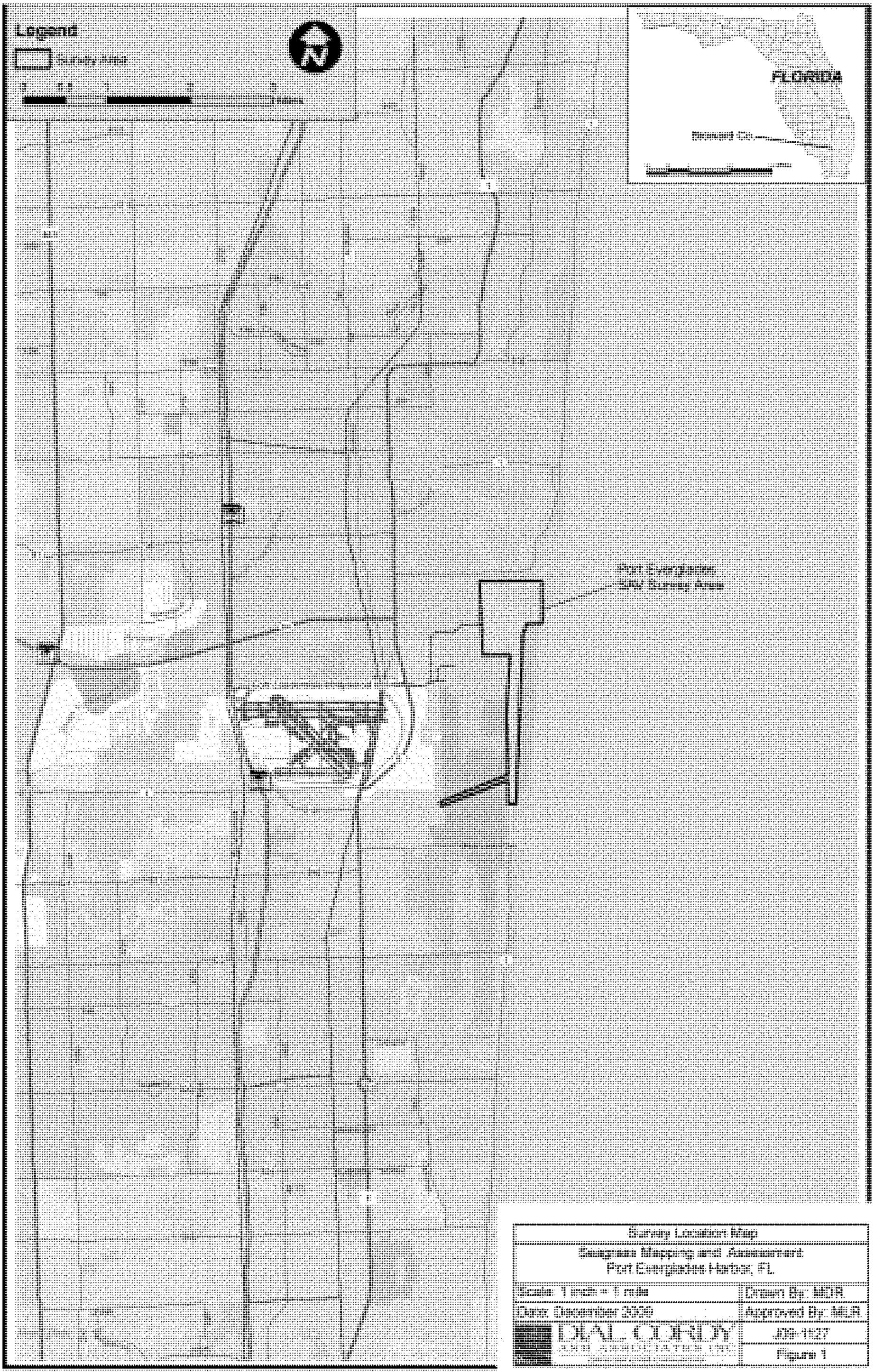
In 2006, the Corps contracted DC&A to revisit Port Everglades and re-survey the seagrass communities to document any changes that my have occurred in the preceding five to six years. These results are reported in DC&A (2006) and are used for comparison in this report.

In 2009, the Corps contracted DC&A to revisit Port Everglades and re-survey the seagrass to document any changes that my have occurred to seagrass communities in the preceding three years. The data collected during this study and related composite resource maps are summarized in this report.

Halophila johnsonii was listed as a threatened species by National Marine Fisheries Service (NMFS) on September 14, 1998 (63 FR 49035) and a re-proposal to designate critical habitat pursuant to Section 4 of the Endangered Species Act (ESA) was published on December 2, 1998 (64 FR 64231). The final rule for critical habitat designation for *H. johnsonii* was published April 5, 2000 (Federal Register, vol. 65, No. 66). *H. johnsonii* has one of the most limited geographic ranges of all seagrass species. It is only known to occur between Sebastian Inlet and northern Biscayne Bay on the east coast of Florida (Kenworthy 1997). As stated in earlier reports (DC&A 1999) and the findings of this survey, *H. johnsonii* occurs within the AIWW south of the turning basin for Port Everglades, in the Dania Cut-Off Canal (DCC), and within the area considered for widening and deepening.

2.0 TECHNICAL APPROACH

This section describes the technical approach used to collect and analyze data associated with the environmental baseline study. Previous resource surveys were conducted in late summer 1999 and 2000, and in May 2001 and June 2006. The most current data was collected in July and August 2009.


Legend
Survey Area
FLORIDA
Broward Co.
Port Everglades
SAV Survey Area
Survey Location Map
Seagrass Mapping and Assessment
Port Everglades Harbor, FL
Scale: 1 inch = 1 mile
Drawn By: MDR
Approved By: MLR
DIAL CORDY
AND ASSOCIATES INC
Figure 1

2.1 Marine Resource Survey

A description of methods utilized to document and characterize marine seagrass communities within the study area (Figure 1) are described below. Surveys were conducted from September 6-10, 1999, September 19-21, 2000, May 16-17, 2001, June 22-25, 2006, July 23-August 3, 2009 (DC&A 1999, 2001, 2006 and this study).

2.2.1 Seagrass Community

Descriptions of methods used to assess seagrass communities within the Port area are included in this section.

2.2.1.1 Location of Survey Transects

The location of survey transects for the 2009 survey ranged from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC (Figure 2). Transects were located in areas previously surveyed in 1999, 2000 and 2006 so that temporal comparisons could be made.

2.2.1.2 Seagrass Mapping

In 1999-2000 marine seagrass distribution was mapped along 62 transects by locating the end positions using Differential Global Positioning System (DGPS), laying a weighted line marked in one-meter increments from the shore, and then conducting a visual diver survey along the weighted line to document seagrass distribution and occurrence from the shore to the edge of channel. Seagrass habitat and bottom type observed while crossing each transect were noted. Divers drift-dove to the next transect, and if any seagrass was found between transects, a GPS position at the start and end of the grass bed was recorded and the width of the grass bed estimated. Information recorded on seagrass habitat type and distribution was transferred from field logs and entered into a spreadsheet. Descriptions of habitat classifications are shown in Table 1. This approach allowed a visual representation of species' associations and occurrences across the shelf, channel, and slope as compared with bottom depth. Maps were produced for all stations surveyed that had seagrass present. A GIS map (ArcView) and database were created to illustrate seagrass distributions throughout the study area.

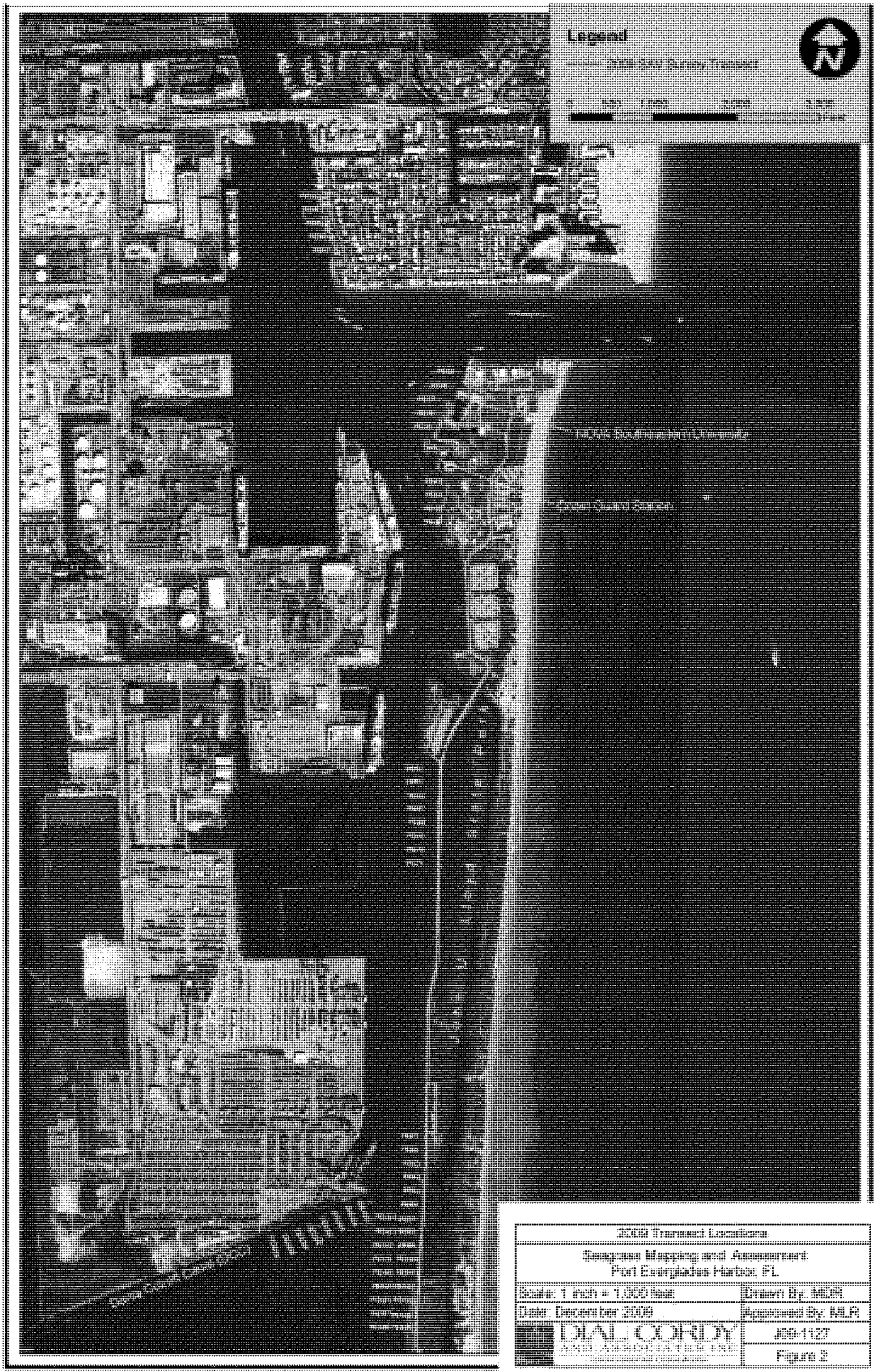

Legend
Coast Guard Station
2009 Transect Locations
Seagrass Mapping and Assessment
Port Everglades Harbor, FL
Scale: 1 inch = 1,000 feet
Drawn By: MDR
Date: December 2009
Approved By: MLR
DIAL CORDY
Figure 2

Table 1 Habitat Classification System Used for Mapping of Seagrass Species

Habitat Types	Description
Halophila decipiens	Monospecific bed of this species
Halophila johnsonii	Monospecific bed of this species
Halodule wrightii	Monospecific bed of this species
Syringodium filiforme	Monospecific bed of this species
Mixed Submerged Aquatic Vegetation	*S. filiforme or H. wrightii* with *H. decipiens*
Mixed Submerged Aquatic Vegetation with *H. johnsonii*	*S. filiforme* and or *H. wrightii* with *H. johnsonii*
Mixed Submerged Aquatic Vegetation with *H. johnsonii* and *H. decipiens*	*H. wrightii* with both species of *Halophila*
Unvegetated Bottom	Sand, silt or shell substrate with no seagrass or live bottom, may have marine algae present
Live-Bottom Habitat	Sponge and soft coral community over thin veneer of silty-sand

Similar methods were used in the 2006 surveys. Since baseline seagrass maps now existed for the area, a reconnaissance of the area was performed first. Divers swam the entire shoreline of the study area noting the occurrence of seagrass beds and recording each occurrence in real time with the DGPS and HYPACK software. This allowed the survey team to roughly assess the current distribution of seagrasses in the study area. Then seagrass transects were established in the areas where grass occurred to assess the coverage, abundance, and density. In total 26 seagrass transects were established in 2006. Transect locations were spaced similarly to the previous surveys and care was taken to include transects that would encompass all of the beds encountered.

In 2009 a reconnaissance of the survey areas was performed first. Divers swam the entire shoreline of the study area noting the occurrence of seagrass beds and recording each occurrence in real time with DGPS and HYPACK software. In addition to the reconnaissance,benthic resource GPS points taken in the summer of 2008 were verified for occurrence of seagrasses (Jocelyn Karaszia personal communication June 18, 2008). This allowed the survey team to roughly assess the current distribution of seagrasses in the study area. Then seagrass transects were established in the areas where seagrass occurred to assess the coverage, abundance, and density according to the Johnson's Seagrass Recovery Survey Protocol for large survey areas (Fonseca et al. 1998). In total 54 seagrass transects, spaced 50m apart in areas of seagrass coverage were surveyed in 2009.

2.2.1.3 Seagrass Occurrence, Abundance, and Density

To obtain biological data regarding the location, occurrence, abundance, and density of marine seagrass, a line point intercept survey was performed along each transect. For each transect in 2009, the average percent (percent of one hundred 10 x 10 cm sub-units within a $1m^2$ quadrat that contains at least one seagrass shoot) was estimated in $1m^2$ quadrats at 5m intervals along the transect line (Virnstein 1995; Fonseca et al. 1998; Braun-Blanquet 1965). Similar methods were used in 1999, 2000, and 2006, see DC&A (2006). Specific data recorded within each $1m^2$ quadrat for each seagrass species present included the number of sub-units containing at least one shoot, an average cover abundance score (Braun-Blanquet 1965), a description of substrate type, and any other observations considered useful. The cover abundance scale is discussed below.

The cover abundance scale was computed beginning at the zero point and at 5m intervals along each transect. The content of each quadrat was visually assessed and a cover abundance scale value assigned to the seagrass coverage.

The scale values are:

0.1 = Solitary shoots with small cover
0.5 = Few shoots with small cover
1.0 = Numerous shoots but less than 5% cover
2.0 = Any number of shoots but with 5-25% cover
3.0 = Any number of shoots but with 25-50% cover
4.0 = Any number of shoots but with 50-75% cover
5.0 = Any number of shoots but with >75% cover

From the survey of quadrats along each transect, frequency of occurrence, abundance, and density of seagrass was computed as follows:

Frequency of occurrence = Number of occupied sub-units/total number of sub-units
Abundance = Sum of cover scale values/number of occupied quadrats
Density = Sum of cover scale values/total number of quadrats

2.2.1.4 Analysis and Interpretation of Seagrass Data

Distribution of seagrass community types and their potential occurrence in an area were mapped for each transect from survey data. Frequency of occurrence, abundance, and density were calculated from the quadrat data based on Braun-Blanquet (1965) methodology.

3.0 RESULTS

This section includes a description and review of the results of the marine resources survey. It outlines the findings of the seagrass community survey, including species occurrence, abundance, and density for both of the previous surveys and the most current sampling event.

3.1 Seagrass Communities

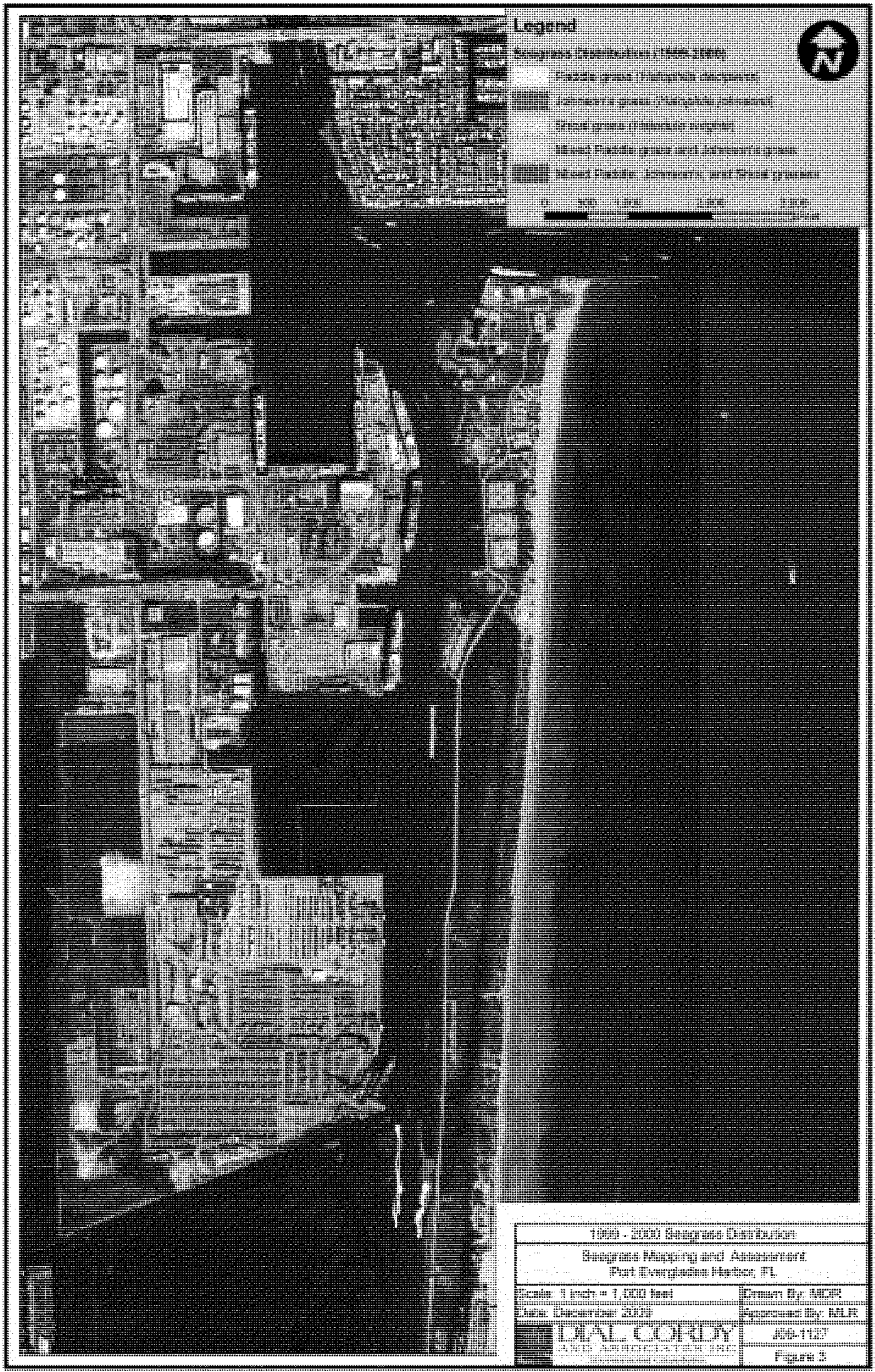
Seagrass habitat cover type, abundance, and density for the study area are described below. Distribution and occurrence observations for the 1999 survey ranged from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC to Port Denison (DC&A 1999). Seagrass surveys in 2000 were conducted within the ICWW south of the DCC to the Sheridan Street bridge (DC&A 2001). The combined 1999-2000 data for the survey area (1000 feet south of DCC) were used to create seagrass maps for 1999-2000. To field verify whether seagrass occurred in the Outer Entrance Channel (OEC), as reported by the Broward County Department of Planning and Environmental Protection (DPEP) staff (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County), an integrated video survey was performed in 2001 within the Federal Channel (DC&A 2001).

3.1.1 Seagrass Species Frequency of Occurrence, Abundance, and Density 1999-2000

General Occurrence

Marine seagrass species observed within the study area included *Halodule wrightii, Halophila decipiens*, and *Halophila johnsonii*. Of the 62 transects surveyed in 1999-2000 (Figure 3), marine seagrass species were observed at 19 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 2. DPEP divers documented the occurrence of *H. decipiens* within the OEC (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County). Video surveys within the channel confirmed the presence of isolated patchy beds of *H. decipiens* in 45 feet of water, diver transects were not performed within the channel.

Seagrass occurrence within the interior areas consisted of mixed Submerged Aquatic Vegetation (SAV) with *H. decipiens*, *H. wrightii*, and *H. johnsonii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens* (Figure 3).


Legend
1999 - 2000 Seagrass Distribution
Seagrass Mapping and Assessment
Port Everglades Harbor, FL
Scale: 1 inch = 1,000 feet
Drawn By: MCR
Date: December 2000
Approved By: MLR
DIAL CORDY
Figure 3

Frequency of Occurrence

H. johnsonii

H. johnsonii occurred within 11 of the 62 transects sampled. Frequency of occurrence values ranged from 0 to 25% with a mean of 11%.

Other species

H. decipiens occurred within 11 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 67% with a mean of 12%. In comparison, *H. wrightii* had a range of occurrence values between 0 to 24% with a mean of 8% over the study area.

Abundance

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover

H. johnsonii

Abundance values for *H. johnsonii* ranged from 0 to 4 for transects sampled. The average abundance for *H. johnsonii* in the Port Everglades area surveyed was 1.1 (< 5% cover). *H. johnsonii* had the highest abundance values of all species over all transects.

Other Species

Cover abundance for *H. wrightii* was low as it only occurred in 4 of the 62 transects sampled. The abundance values ranged from 0.1 to 1.5 with a mean 0.34. *H. decipiens* however, had values for cover abundance in the 0.1 to 5.0 range with a mean of 0.65.

Density

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values are very low because values were averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for this species was the highest of all species in the study area, with an average value of 0.32 per meter squared. The range of density values for *H. johnsonii* was 0 to 1.0.

Other Species

Halophila decipiens had the second highest density values encountered, with a range of 0.01 to 2.50 with an average of 0.32. *H. wrightii* had the lowest densities of the three species with values ranging from 0 to 0.75 with a mean of 0.15.

3.1.2 Seagrass Species Frequency of Occurrence, Abundance, and Density 2006

General Occurrence

Marine seagrass species observed within the study area included *H. wrightii*, *H. decipiens*, and *H. johnsonii*. Of the 34 transects surveyed in 2006 (Figure 4), marine seagrass species were observed at 25 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 3. Seagrass occurrence within the study areas consisted of mixed beds with *H. decipiens* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens* (Figure 4).

Frequency of Occurrence

H. johnsonii

H. johnsonii occurred within 12 of the 34 transects sampled. Frequency of occurrence values ranged from 0 to 44% with a mean of 23%.

Other species

H. decipiens occurred within 20 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 71% with a mean of 22%. In comparison, *H. wrightii* had an occurrence of 5% over the study area.

Abundance

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover

H. johnsonii

Abundance values for *H. johnsonii* ranged from 0 to 3 for transects sampled. The average abundance for *H. johnsonii* in the Port Everglades area surveyed was 1.1 (< 5% cover). *H. johnsonii* had the highest abundance values of all species over all transects.

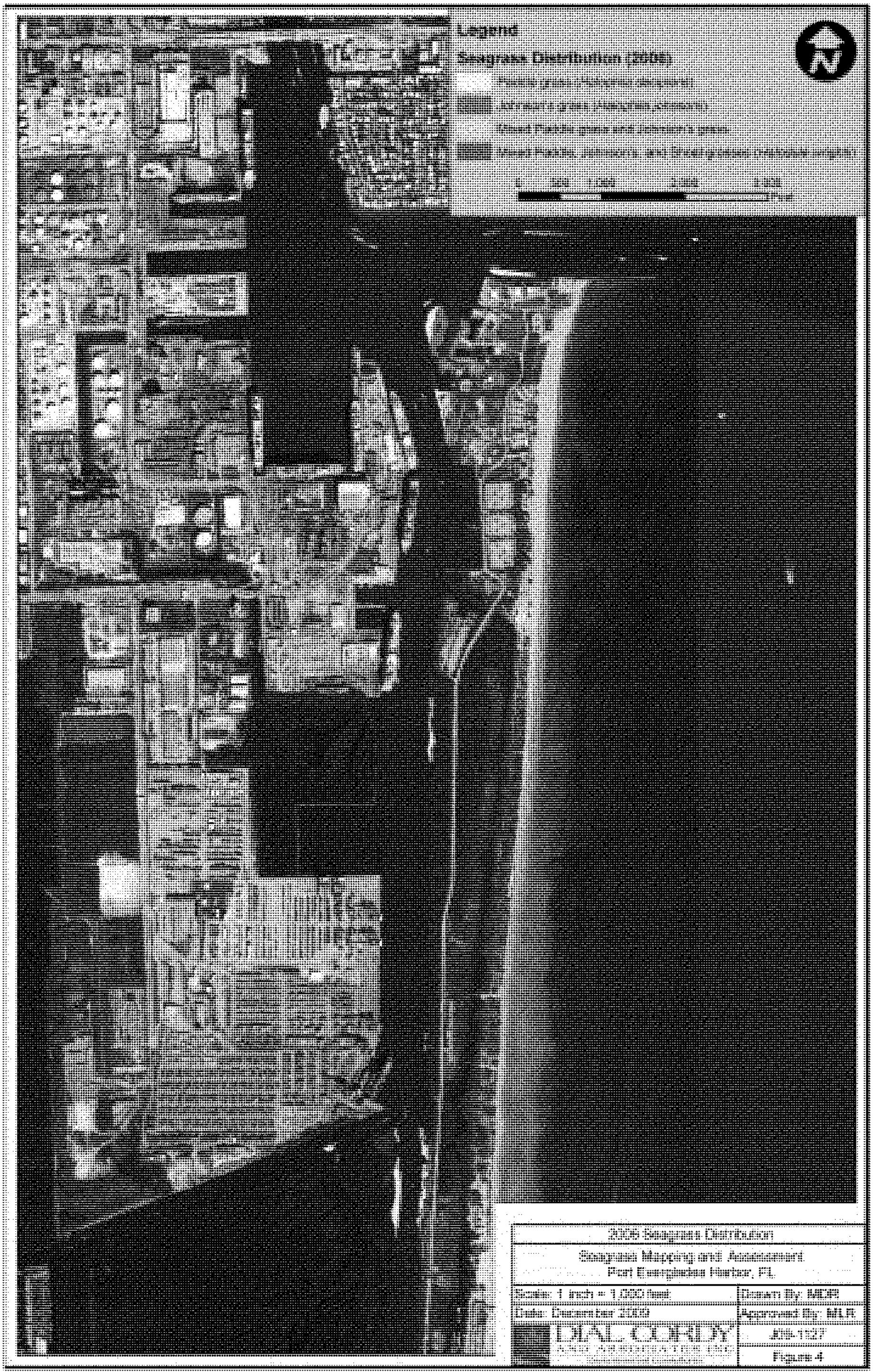

Legend
Seagrass Mapping and Assessment
Port Everglades Harbor, FL
Scale: 1 inch = 1,000 feet
Drawn By: MDR
Date: December 2009
Approved By: MLR
DIAL CORDY
Figure 4

Table 3 Seagrass Frequency of Occurrence, Abundance, and Density Values for Port Everglades Survey Transects for 2006 Survey

		Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii
Transect		Frequency of Occurrence			Abundance			Density		
PE06-1			0.70	0.39		0.54			0.70	
PE06-5			0.05			0.40			0.20	
PE06-6			0.15			0.10			0.07	
PE06-8			0.14	0.14		1.33	0.70		0.33	0.18
PE06-9			0.10	0.16		0.56	0.10		0.09	0.03
PE06-10				0.15			0.10			0.02
PE06-12			0.30	0.20		2.00	2.00		0.80	0.40
PE06-13				0.43			2.00			0.56
PE06-14			0.34	0.44		1.28	2.00		0.89	0.56
PE06-15			0.06			0.10				0.05
PE06-16			0.71			2.67			2.67	
PE06-17			0.06			1.00			0.50	
PE06-20			0.02			0.10			0.03	
PE06-21			0.12			0.10			0.01	
PE06-22			0.17	0.27		2.00	1.00		0.33	0.33
PE06-23			0.04	0.03		0.10	0.10		0.02	0.02
PE06-24		0.05	0.17	0.17	0.10	2.00	2.00	0.02	0.33	0.33
PE06-25			0.08	0.13		0.10	1.00		0.03	0.25
PE06-27			0.11			1.00			0.40	
PE-0631			0.46			1.06			0.70	
PE06-32			0.45			0.10			0.08	
PE06-33			0.23	0.20		0.73	3.00		0.44	0.60

Other Species

Cover abundance for *H. wrightii* was low as it only occurred in 1 of the 34 transects sampled. *H. decipiens* however, had values for cover abundance in the 0.1 to 3 range with a mean of 0.88.

Density

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values are very low because values were averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for this species was the highest of all species in the study area, with values not exceeding an average value of 0.33 per meter squared. The range of density values for *H. johnsonii* was 0 to 0.86.

Other Species

Halophila decipiens had the second highest density values encountered, with a range of 0.01 to 2.67 with an average of 0.43. *H. wrightii* had the lowest densities of the three species with value of 0.02.

3.1.3 Seagrass Species Frequency of Occurrence, Abundance, and Density 2009

General Occurrence

Marine seagrass species observed within the study area included *H. wrightii, H. decipiens,* and *H. johnsonii.* Of the 54 transects surveyed in 2009 (Figure 2), marine seagrass species were observed at 36 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 4. Seagrass occurrence within the study areas consisted of mixed beds with *H. decipiens*, *H. johnsonii* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens* (Figure 5).

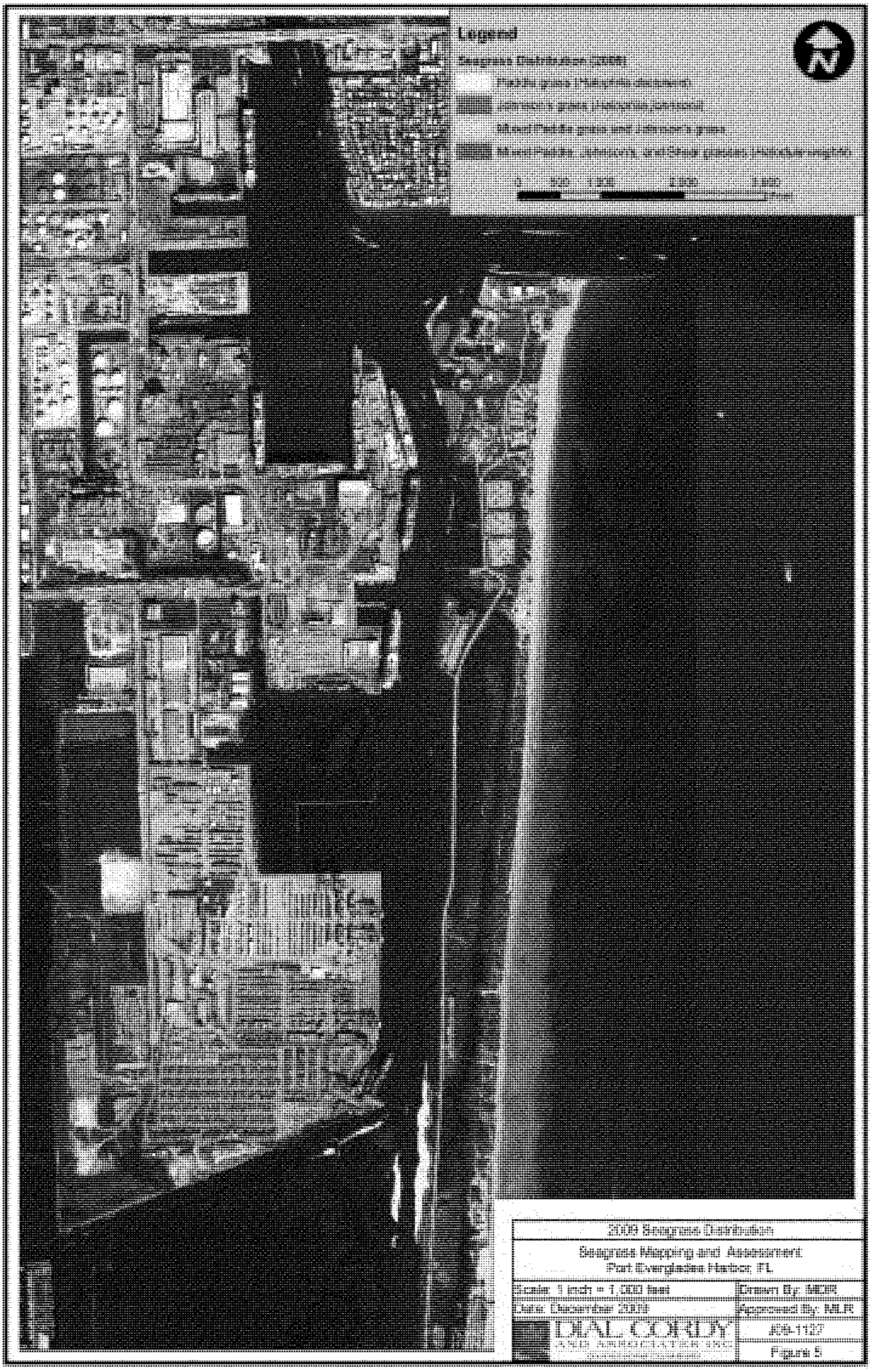
Frequency of Occurrence

H. johnsonii

H. johnsonii occurred within 22 of the 54 transects sampled. Frequency of occurrence values ranged from 0 to 29% with a mean of 8% along transects containing *H. johnsonii*.

Table 4 Seagrass Frequency of Occurrence, Abundance, and Density Values for Port Everglades Survey Transects for 2009 Survey

		Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii
Transect		Frequency of Occurrence			Abundance			Density		
PE-09-03				0.05			1.00			0.40
PE09-35			0.00			0.10			0.00	
PE09-36			0.00			0.40			0.20	
PE09-37			0.00	0.00		1.00	1.00		0.04	0.04
PE09-38				0.15			0.65			0.31
PE09-39				0.00			0.73			0.40
PE09-43				0.17			0.72			0.52
PE09-44				0.21			0.78			0.44
PE09-45				0.10			1.00			0.29
PE09-46			0.01	0.07		1.00	1.00		0.17	0.33
PE09-92			0.02			2.00			0.40	
PE09-93			0.03			1.05			0.30	
PE09-94			0.14	0.29		1.00	0.75		0.33	0.34
PE09-95			0.27			1.03			0.56	
PE09-96			0.42	0.00		1.33	0.10		0.92	0.01
PE09-97			0.04	0.06		1.03	0.40		0.21	0.08
PE09-98			0.13	0.03		0.87	0.55		0.41	0.07
PE09-99			0.11	0.03		3.50	1.00		0.47	0.07
PE09-100			0.30	0.13		0.90	2.50		0.68	0.42
PE09-101			0.40	0.00		2.03	0.10		1.45	0.01
PE09-102		0.07	0.04	0.15	0.10	0.10	1.00	0.02	0.05	0.20
PE09-103			0.33	0.01		1.03	0.10		0.62	0.01
PE09-104			0.06	0.08		0.40	1.00		0.13	0.11
PE09-106			0.12			1.50			0.38	
PE09-108			0.07			0.78			0.39	
PE09-109			0.05			0.55			0.24	
PE09-110			0.17			0.64			0.46	
PE09-111			0.23			1.00			0.50	
PE09-112			0.13			1.00			0.29	
DCC09-02			0.25			1.00			1.00	
DCC09-03			0.05	0.17		0.40	1.00		0.20	0.17
DCC09-04			0.00			0.10			0.02	
DCC09-05			0.01			0.10			0.01	
DCC09-06			0.19			1.50			0.67	
DCC09-07				0.02			1.00			0.10


Legend
Seagrass Mapping and Assessment
Port Everglades Harbor, FL
Scale: 1 inch = 1,000 feet
Drawn By: MDR
Approved By: MLR
DIAL CORDY
Figure 5

Other species

H. decipiens occurred within 20 out of 54 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 39% with a mean of 13% along transects that contained *H. decipiens*. In comparison, *H. wrightii* had an occurrence of 7% at the single transect where it occurred.

Abundance

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0.1 to 5, where 0.1 is a single shoot, 0.5 is a few shoots, 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover.

H. johnsonii

Abundance values ranged from 0.1 to 3 along transects where *H. johnsonii* occurred. The average abundance for *H. johnsonii* along transects in the Port Everglades area surveyed was 0.8 (< 5% cover). *H. johnsonii* had lower abundance scores than *H. decipiens*.

Other Species

Abundance values ranged from 0.1 to 4 along transects where *H. decipiens* occurred. The average abundance for *H. decipiens* was 1.0 (<5% cover). H. decipiens had the highest abundance of seagrasses surveyed in 2009.Cover abundance for *H. wrightii* was low as it only occurred in 1 of the 49 transects sampled.

Density

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values were low because values were averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for *H. johnsonii* was 0.2 for all transects surveyed that included *H. johnsonii*. The range of density values for *H. johnsonii* across all transects was 0 to 0.5.

Other Species

Halophila decipiens had the highest density values encountered, with a range of 0 to 1 with an average of 0.4. *H. wrightii* had the lowest densities of the three species, at a single transect, with value of 0.02.

3.1.4 Comparison of 1999-2000 to 2009 Seagrass Data

The seagrass communities surveyed in the summer of 2009 within the study area cover a greater area when compared to the 1999-2000 and 2006 seagrass community distribution (Table 5). In general, seagrass beds in the southern portion of the project area have expanded, while seagrass beds to the north of the entrance channel have diminished (Figure 6). Overall, there has been a notable increase in monospecific beds of *H. decipiens* and *H. johnsonii*; while mixed beds have decreased since 1999-2001. *H. wrightii* cover has decreased since 1999-2000.

Noticeable losses of seagrass have occurred in the northern reaches of the survey area. The area north of the channel has experienced scouring and subsidence due to some action and the associated seagrasses are either no longer there or the beds are greatly reduced in size. This may be from storm events or some other physical disturbance.

The area just south of the channel, near the Coast Guard facility and NOVA Southeastern has increased in seagrass coverage since 1999-2000. The beds near the Coast Guard facility and NOVA Southeastern have transitioned from monospecific beds of *H. johnsonii* (1999-2000) to monospecific beds of *H. johnsonii* and *H. decipiens* in 2006 and 2009. *H. johnsonii* is found in the shallower water, when compared to *H. decipiens*. The predominant seagrass in this area over time has been *H. johnsonii*.

South of the Coast Guard station, adjacent to John U. Lloyd State Park, seagrass cover is low due to the narrow shelf available for seagrass colonization. Near the outlet of the DCC, the shelf widens and provides more available habitat for seagrasses, and from 1999-2000 to 2009 seagrass beds have consistently been documented here. In contrast to beds near the channel inlet, *H. decipiens* is the predominant seagrass, which may be a result of greater depth in this portion of the survey area.

Seagrass cover has increased from 1999-2000 to 2009 within the DCC. Shallow monospecific beds of *H. johnsonii* transition into mixed *H. johnsonii* and *H. decipiens* beds which transition into monospecific beds of *H. decipiens*, across depth.

Frequency of occurrence, abundance and density values are comparable from 1999-2000 to 2009. Many beds have expanded in area coverage over the 10-year survey period, while only a few beds have contracted. Some succession has occurred; most notably with the reduction of *H. wrightii* within the AIWW.

In conclusion, the seagrass communities encountered within the study area were similar in species distribution, while total seagrass coverage has increased since 1999-2000.

Table 5 Comparison of Seagrass Acreage 1999-2000, 2006, and 2009 Port Everglades

Bed Type	1999-2000 Acres	2006 Acres	2009 Acres
H. decipiens	3.29	4.47	6.58
H. johnsonii	2.85	2.80	4.68
H. wrightii	0.61	0.00	0.00
Mixed *H. johjnsonii/H. decipiens*	0.00	1.08	0.46
Mixed *H.decipiens/H.johsonii/H. wrightii*	1.96	0.09	0.26
Totals	**8.71**	**8.44**	**11.98**

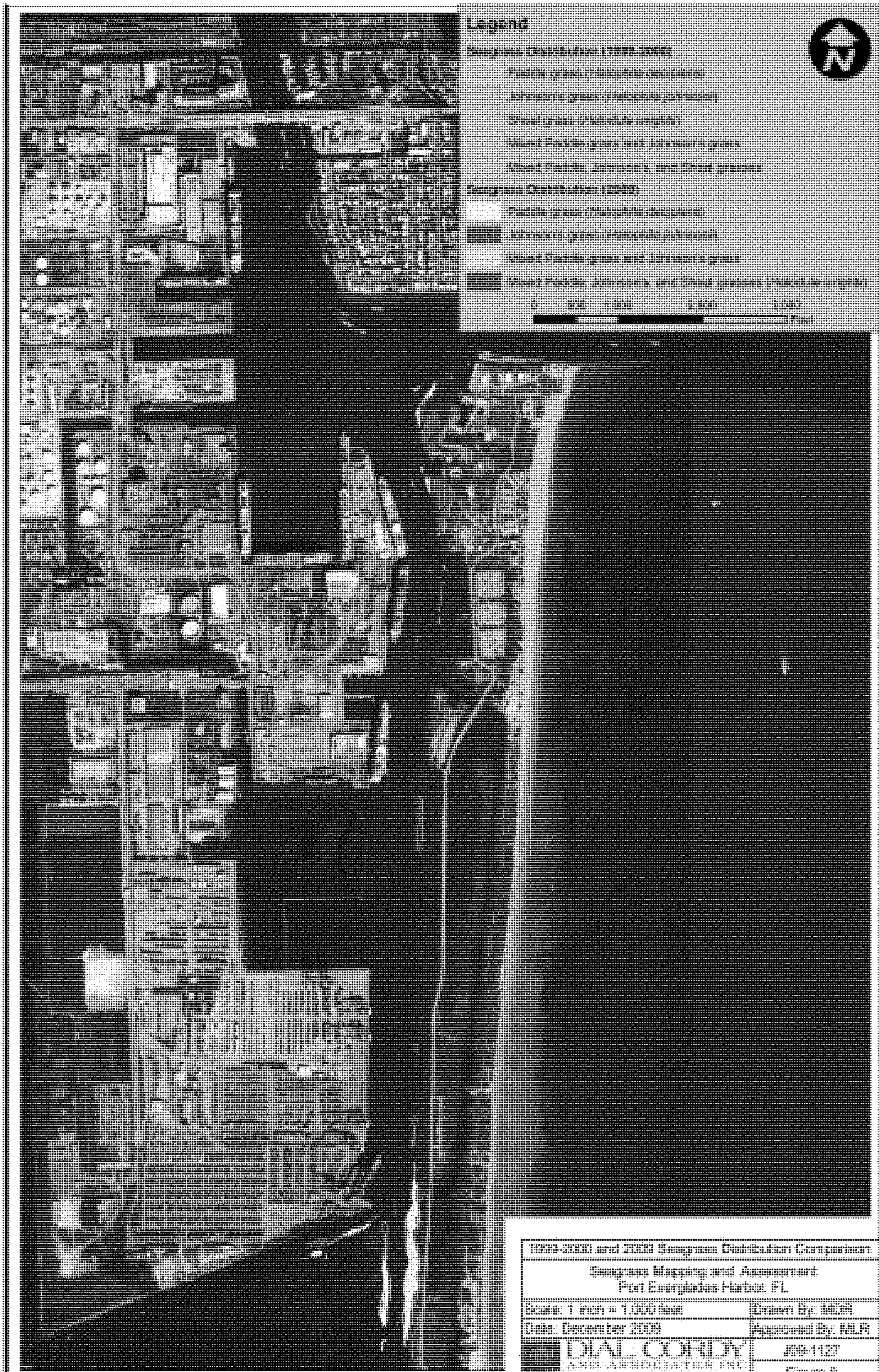

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Figure 6

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Seagrass Mapping and Assessment Port Everglades Harbor

Final Report

October 5, 2006

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U.S. Army Corps of Engineers
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1.0 INTRODUCTION

Dial Cordy and Associates Inc. (DC&A) was originally subcontracted by Gulf Engineers and Consultants, Inc. (GEC) to conduct an environmental baseline and impact assessment for proposed deepening and widening of Port Everglades, Broward County, FL for the U.S. Army Corps of Engineers, Jacksonville District (Corps), under contract No. DACW17-99-D-0043 in 1999. Data was collected in an initial seagrass survey in 1999 (DC&A 1999). That study included baseline mapping of seagrasses within the project area at Port Everglades and the results are found in Dial Cordy 2001.

In 2006, the Corps contracted DC&A to revisit Port Everglades and re-survey the seagrass to document any changes that my have occurred to seagrass communities in the preceding five to six years. The data collected during this study and related composite resource maps are summarized in this report.

Halophila johnsonii was listed as a threatened species by NMFS on September 14, 1998 (63 FR 49035) and a re-proposal to designate critical habitat pursuant to Section 4 of the Endangered Species Act (ESA) was published on December 2, 1998 (64 FR 64231). The final rule for critical habitat designation for *H. johnsonii* was published April 5, 2000 (Federal Register, vol. 65, No. 66). *H. johnsonii* has one of the most limited geographic ranges of all seagrass species. It is only known to occur between Sebastian Inlet and northern Biscayne Bay on the east coast of Florida (Kenworthy 1997). As stated in earlier reports (DC&A 1999) and the findings of this survey, *H. johnsonii* occurs within the AIWW south of the turning basin for Port Everglades, in the Dania Cut-Off Canal (DCC), and within the area considered for widening and deepening.

2.0 TECHNICAL APPROACH

This section describes the technical approach used to collect and analyze data associated with the environmental baseline study. Previous resource surveys were conducted in late summer 1999 and 2000, and in May 2001. The most current data was collected in June 2006.

2.1 Marine Resource Survey

A description of methods utilized to document and characterize marine seagrass communities within the study area (Figure 1) are described below. Surveys were conducted on September 6-10, 1999, September 19-21, 2000, May 16-17, 2001 and June 22-25, 2006 (DC&A 1999, 2001).

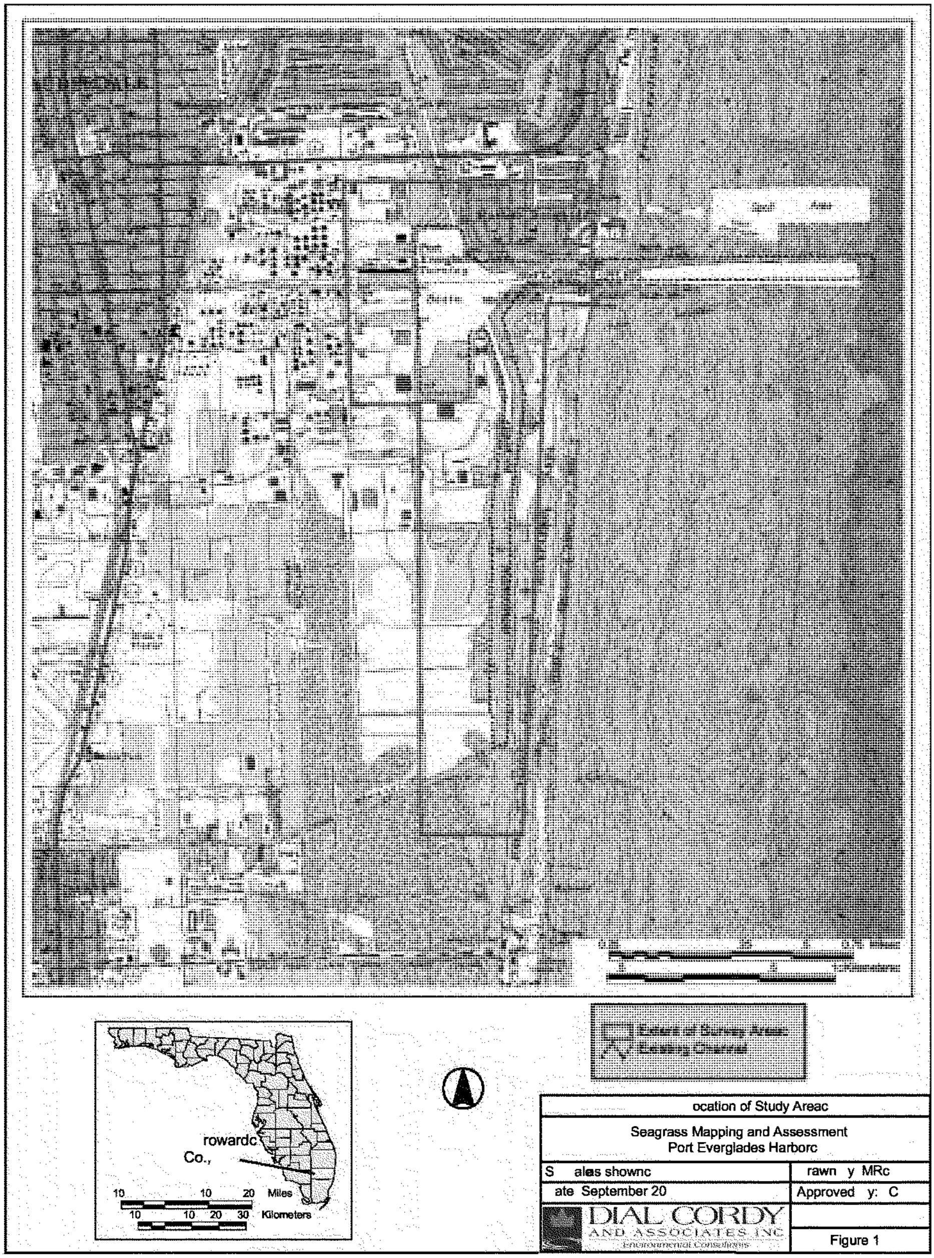
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Figure 1

2.2.1 Seagrass Community

Descriptions of methods used to assess seagrass communities within the Port area are included in this section.

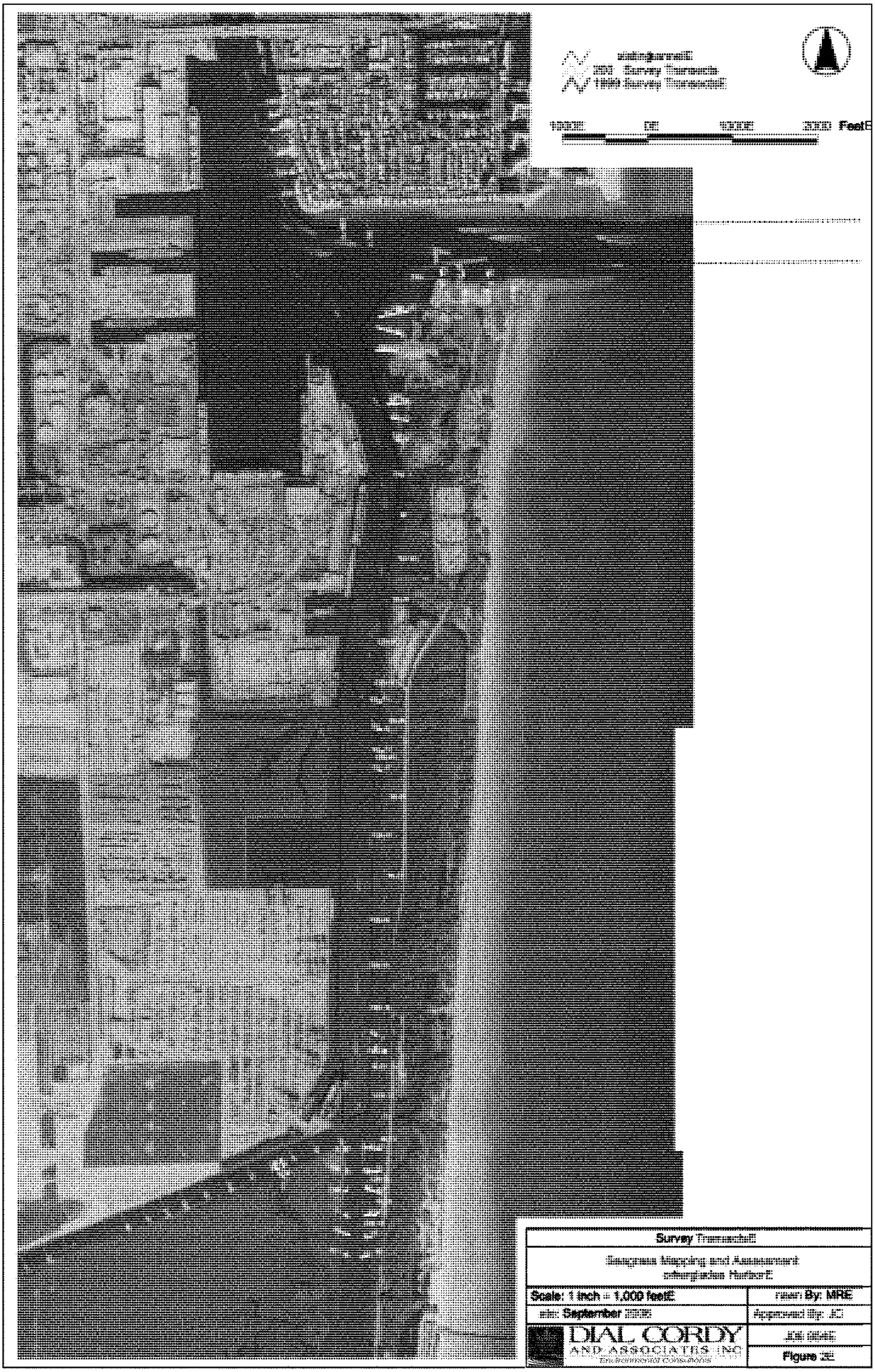
2.2.1.1 Location of Survey Transects

The location of survey transects for the 1999 survey ranged from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC to Port Denison (Figure 2). The most current survey included the locations surveyed in 1999, namely from about 1200 feet north of the Port Everglades Inlet south past the DCC and along the DCC to Port Denison.

2.2.1.2 Seagrass Mapping

In 1999 marine seagrass distribution was mapped along 62 transects by locating the end positions using Differential Global Positioning System (DGPS), laying a weighted line marked in one meter increments from the shore, and then conducting a visual diver survey along the weighted line to document seagrass distribution and occurrence from the shore to the edge of channel. Seagrass habitat and bottom type observed while crossing each transect were noted. Divers drift dove to the next transect, and if any seagrass was found between transects, a GPS position at the start and end of the grass bed was recorded, and the width of the grass bed estimated. Information recorded on seagrass habitat type and distribution was transferred from field logs and entered into a spreadsheet. Descriptions of habitat classifications are shown in Table 1. This approach allowed a visual representation of species' associations and occurrences across the shelf, channel, and slope as compared with bottom depth. Maps were produced for all stations surveyed that had seagrass present. A GIS map (ArcView) and database were created to illustrate seagrass distributions throughout the study area.

Similar methods were used in the 2006 surveys. Since baseline seagrass maps now existed for the area, a reconnaissance of the area was performed first. Divers swam the entire shoreline of the study area noting the occurrence of seagrass beds and recording each occurrence in real time with the DGPS and HYPACK software. This allowed the survey team to roughly assess the current distribution of grasses in the study area. Then seagrass transects were established in the areas where grass occurred to assess the coverage, abundance and density. In total 26 seagrass transects were established in 2006. Transect locations were spaced similarly to the previous surveys and care was taken to include transects that would encompass all of the beds encountered.


Survey
Scale: 1 inch = 1,000 feet
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DIAL CORDY
AND ASSOCIATES INC
Figure

2.2.1.3 Seagrass Occurrence, Abundance, and Density

To obtain biological data regarding the location, occurrence, abundance, and density of marine seagrass, a SCUBA point intercept survey was performed along each transect. For each transect, the average percent (percent of sixteen 25 x 25 cm sub-units within a $1m^2$ quadrat that contains at least one seagrass shoot) was estimated in $1m^2$ quadrats at 10m intervals along the transect line (Virnstein 1995; Fonseca et al. 1998; Braun-Blanquet 1965). Specific data recorded within each $1m^2$ quadrat for each seagrass species present included the number of sub-units containing at least one shoot, an average cover abundance score (Braun-Blanquet 1965), a description of substrate type, and any other observations considered useful. The cover abundance scale is discussed below.

The cover abundance scale was computed beginning at the zero point and at 10m intervals along each transect. The content of each quadrat was visually assessed and a cover abundance scale value assigned to the seagrass coverage.

Table 1 Habitat Classification System Used for Mapping of Seagrass Species

Habitat Types	Description
Halophila decipiens	Monospecific bed of this species
Halophila johnsonii	Monospecific bed of this species
Halodule wrightii	Monospecific bed of this species
Syringodium filiforme	Monospecific bed of this species
Mixed Submerged Aquatic Vegetation	*S. filiforme or H. wrightii* with *H. decipiens*
Mixed Submerged Aquatic Vegetation with *H. johnsonii*	*S. filiforme* and or *H. wrightii* with *H. johnsonii*
Mixed Submerged Aquatic Vegetation with *H. johnsonii* and *H. decipiens*	*H. wrightii* with both species of *Halophila*
Unvegetated Bottom	Sand, silt or shell substrate with no seagrass or live bottom, may have marine algae present
Live-Bottom Habitat	Sponge and soft coral community over thin veneer of silty-sand

The scale values are:

0.1 = Solitary shoots with small cover
0.5 = Few shoots with small cover
1.0 = Numerous shoots but less than 5% cover
2.0 = Any number of shoots but with 5-25% cover
3.0 = Any number of shoots but with 25-50% cover
4.0 = Any number of shoots but with 50-75% cover
5.0 = Any number of shoots but with >75% cover

From the survey of quadrats along each transect, frequency of occurrence, abundance, and density of seagrass was computed as follows:

Frequency of occurrence = Number of occupied sub-units/total number of sub-units
Abundance = Sum of cover scale values/number of occupied quadrats
Density = Sum of cover scale values/total number of quadrats

2.2.1.4 Analysis and Interpretation of Seagrass Data

Distribution of seagrass community types and their potential occurrence in an area were mapped for each transect from survey data. Frequency of occurrence, abundance, and density were calculated from the quadrat data based on Braun-Blanquet (1965) methodology.

3.0 RESULTS

This section includes a description and review of the results of the marine resources survey. It outlines the findings of the seagrass community survey, including species occurrence, abundance, and density for both the previous surveys and the most current sampling event.

3.1 Seagrass Communities

Seagrass habitat cover type, abundance, and density for the study area are described below. Distribution and occurrence observations for the 1999 survey range from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC to Port Denison (Figure 2) (DC&A 1999). To field verify whether seagrass occurred in the Outer Entrance Channel (OEC), as reported by the Broward County Department of Planning and Environmental Protection (DPEP) staff (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County), an integrated video survey was performed in 2001 within the federal channel.

3.1.1 Seagrass Species Frequency of Occurrence, Abundance, and Density 1999-2001

General Occurrence

Marine seagrass species observed within the study area included *Halodule wrightii, Halophila decipiens,* and *Halophila johnsonii.* Of the 62 transects surveyed in 1999 and 2000 (Figure 2), marine seagrass species were observed at 19 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 2. DPEP divers documented the occurrence of *H. decipiens* within the OEC (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County). Video surveys within the channel confirmed the presence of isolated patchy beds of *H. decipiens* in 45 feet of water.

Seagrass occurrence within the interior areas consisted of mixed Submerged Aquatic Vegetation (SAV) with *H. decipiens* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens* (Figure 3).

Frequency of Occurrence

H. johnsonii

H. johnsonii occurred within 11 of the 62 transects sampled. Frequency of occurrence values ranged from 0 to 25% with a mean of 11%.

Other species

H. decipiens occurred within 11 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 67% with a mean of 12%. In comparison, *H. wrightii* had a range of occurrence values between 0 to 24% with a mean of 8% over the study area.

Abundance

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover

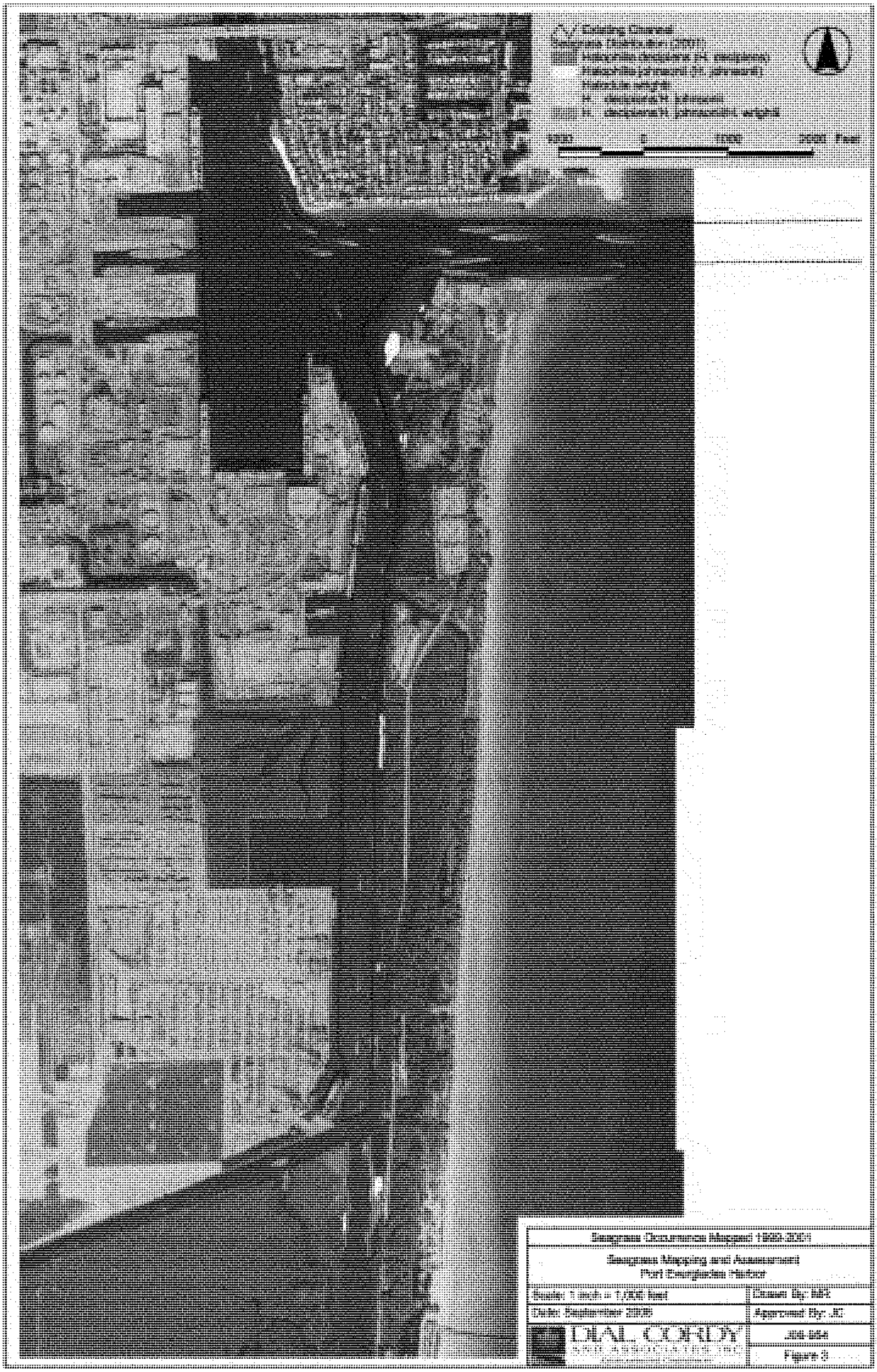
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Figure 3

H. johnsonii

Abundance values for *H. johnsonii* ranged from 0 to 4 for transects sampled. The average abundance for *H. johnsonii* in the Port Everglades area surveyed was 1.1 (< 5% cover). *H. johnsonii* had the highest abundance values of all species over all transects.

Other Species

Cover abundance for *H. wrightii* was low as it only occurred in 4 of the 62 transects sampled. The abundance values ranged from 0.1 to 1.5 with a mean 0.34. *H. decipiens* however, had values for cover abundance in the 0.1 to 5.0 range with a mean of 0.65.

Table 2 Seagrass Frequency of Occurrence, Abundance, and Density Values for Port Everglades Survey Transects for 1999-2000 Survey

		Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii
Transect		**Frequency of Occurrence**			**Abundance**			**Density**		
PE99-1			0.09			0.30			0.15	
PE99-2			0.34			1.25			0.63	
PE99-3			0.02			0.10			0.03	
PE99-6			0.07	0.14		0.30	1.05		0.10	0.35
PE99-7				0.18			0.55			0.22
PE99-8			0.08	0.05		0.50	0.10		0.13	0.03
PE99-10			0.04			0.10			0.01	
PE99-12			0.03	0.15		0.10	0.87		0.05	0.43
PE99-13		0.23		0.17	1.00		2.00	0.40		0.40
PE99-14		0.02	0.06	0.03	0.10	0.50	0.10	0.01	0.06	0.03
PE99-15			0.01	0.02		0.10	0.10		0.02	0.02
PE99-17				0.15			1.00			0.33
PE99-24		0.13			0.50			0.25		
PE99-25		0.06			0.10			0.05		
PE99-32				0.23			1.75			0.70
PE99-34				0.25			1.02			0.64
PE99-35				0.01			0.10			0.02
PE99-36			0.01			0.10			0.01	
DCOC-16			0.03			0.10			0.03	

Density

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values are very low compared to abundance because values are averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for this species was the highest of all species in the study area, with an average value of 0.32 per meter squared. The range of density values for *H. johnsonii* was 0 to 1.0.

Other Species

Halophila decipiens had the second highest density values encountered, with a range of 0.01 to 2.50 with an average of 0.32. *H. wrightii* had the lowest densities of the three species with values ranging from 0 to 0.75 with a mean of 0.15.

3.1.2 Seagrass Species Frequency of Occurrence, Abundance, and Density 2006

General Occurrence

Marine seagrass species observed within the study area included *H. wrightii*, *H. decipiens*, and *H. johnsonii*. Of the 34 transects surveyed in 2006 (Figure 2), marine seagrass species were observed at 25 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 3. Seagrass occurrence within the study areas consisted of mixed beds with *H. decipiens* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens* (Figure 4).

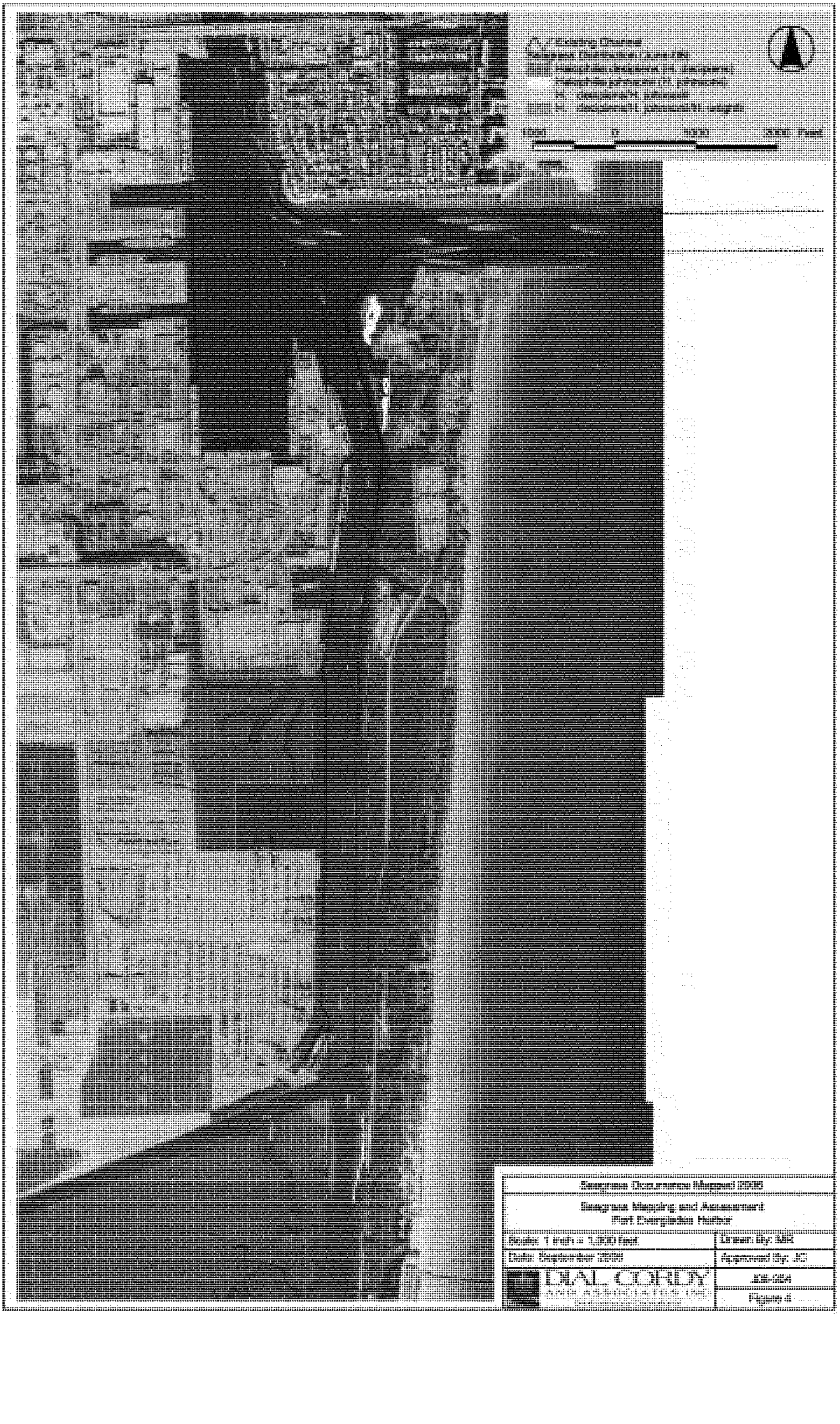
Frequency of Occurrence

H. johnsonii

H. johnsonii occurred within 12 of the 34 transects sampled. Frequency of occurrence values ranged from 0 to 44% with a mean of 23%.

Table 3 Seagrass Frequency of Occurrence, Abundance, and Density Values for Port Everglades Survey Transects for 2006 Survey

		Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii
Transect		Frequency of Occurrence			Abundance			Density		
PE06-1			0.70	0.39		0.84			0.70	
PE06-5			0.05			0.40			0.20	
PE06-6			0.15			0.10			0.07	
PE06-8			0.14	0.14		1.33	0.70		0.33	0.18
PE06-9			0.10	0.16		0.55	0.10		0.09	0.03
PE06-10				0.15			0.10			0.02
PE06-12			0.30	0.20		2.00	2.00		0.50	0.40
PE06-13				0.43			2.00			0.86
PE06-14			0.34	0.44		1.28	2.00		0.39	0.86
PE06-15			0.06			0.10				0.05
PE06-16			0.71			2.67			2.67	
PE06-17			0.06			1.00			0.50	
PE06-20			0.02			0.10			0.03	
PE06-21			0.12			0.10			0.01	
PE06-22			0.17	0.27		2.00	1.00		0.33	0.33
PE06-23			0.04	0.03		0.10	0.10		0.02	0.02
PE06-24		0.05	0.17	0.17	0.10	2.00	2.00	0.02	0.33	0.33
PE06-25			0.08	0.13		0.10	1.00		0.03	0.25
PE06-27			0.11			1.00			0.40	
PE-0631			0.46			1.05			0.70	
PE06-32			0.45			0.10			0.08	
PE06-33			0.23	0.20		0.73	3.00		0.44	0.60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Port Everglades Harbor
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Other species

H. decipiens occurred within 20 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 71% with a mean of 22%. In comparison, *H. wrightii* had an occurrence of 5% over the study area.

Abundance

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover

H. johnsonii

Abundance values for *H. johnsonii* ranged from 0 to 3 for transects sampled. The average abundance for *H. johnsonii* in the Port Everglades area surveyed was 1.1 (< 5% cover). *H. johnsonii* had the highest abundance values of all species over all transects.

Other Species

Cover abundance for *H. wrightii* was low as it only occurred in 1 of the 34 transects sampled. *H. decipiens* however, had values for cover abundance in the 0.1 to 3 range with a mean of 0.88.

Density

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values are very low compared to abundance because values are averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for this species was the highest of all species in the study area, with values not exceeding an average value of 0.33 per meter squared. The range of density values for *H. johnsonii* was 0 to 0.86.

Other Species

Halophila decipiens had the second highest density values encountered, with a range of 0.01 to 2.67 with an average of 0.43. *H. wrightii* had the lowest densities of the three species with value of 0.02.

3.1.3 Comparison of 1999 to 2006 Seagrass Data

The seagrass communities encountered in June 2006 within the study area are very similar in composition to the seagrass communities encountered in the previous sampling events. Some loss and succession within these seagrass communities has occurred, but overall the condition and location of the seagrass beds has remained largely unchanged. Table 4 shows the break down of seagrass type by acreage for the previous surveys (1999-2001) compared to the most recent survey. Overall, only a 0.3-acre reduction in seagrass is noted with the entire project area. Some succession, expansion and losses have seagrasses have occurred, but overall the acreage remains almost the same.

Noticeable losses have seagrass have occurred in the northern reaches of the survey area. The area north of the channel has experienced scouring and subsidence due to some action and the associated seagrasses are either no longer there or the beds are greatly reduced in size. This may be from storm events or some other activity within the Port.

The area near the Coast Guard facility has seen an increase in seagrass coverage since 1999. This is particularly true in the area just south of the Coast Guard basin. The H. johnsonii beds near the entrance of the Coast Guard basin have also expanded in the last 5 years.

Frequency of occurrence, abundance and density numbers are very comparable over the span of the surveys conducted. No noticeable changes in density or abundance have occurred within persistent beds. Some succession has occurred; most notably with the reduction in *H. wrightii* is some locations. In at least one location *H. wrightii* appears to have been replaced almost entirely with *H. decipiens*.

Table 4 Comparison of Seagrass Acreage1999 to 2006 Port Everglades

Bed Type	1999-2001 Acres	2006 Acres
H. decipiens	3.29	4.47
H. johnsonii	2.85	2.80
H. wrightii	0.61	0.00
Mixed *H. johjnsonii/H. decipiens*	0.00	1.08
Mixed *H.decipiens/H.johsonii/H. wrightii*	1.96	0.09
Totals	**8.71**	**8.44**

In conclusion, the seagrass communities encountered within the study area are very similar to those encountered originally in 1999. Some changes in community structure have occurred, but overall the location and density of seagrasses throughout Port Everglades have remained constant. Some losses have occurred, particularly in the northern extents of the study area. These losses are most likely attributed to loss of material due to erosion during the previous two seasons' storm events.

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Seagrass Mapping and Assessment – Between the Nearshore Hardbottom and Middle Reef on the South Side of Port Everglades Entrance Channel

Final Report

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1.0 INTRODUCTION

Dial Cordy and Associates Inc. (DC&A) was contracted by David Miller and Associates (DMA) to conduct a seagrass survey for the area between the nearshore hardbottom and middle reef adjacent to the south side of the Port Everlglades entrance channel and to document the presence and extent of a previously known seagrass bed west of the nearshore hardbottom, also on the south side of the entrance channel (Figure 1).

Broward County and federal and state regulators conducted qualitative seagrass surveys in the area of the Port Everglades outer entrance channel in July 2013 and took GPS points at two locations (BC1 and BC2) that defined the edge of a seagrass bed between the nearshore hardbottom and middle reef. *Halophila decipiens* was identified as present within the seagrass bed, and members of the dive suggested that *H. johnsonii* may also have been present. Therefore, a survey method consistent with the Johnson's seagrass protocol was justified (NMFS 2002).

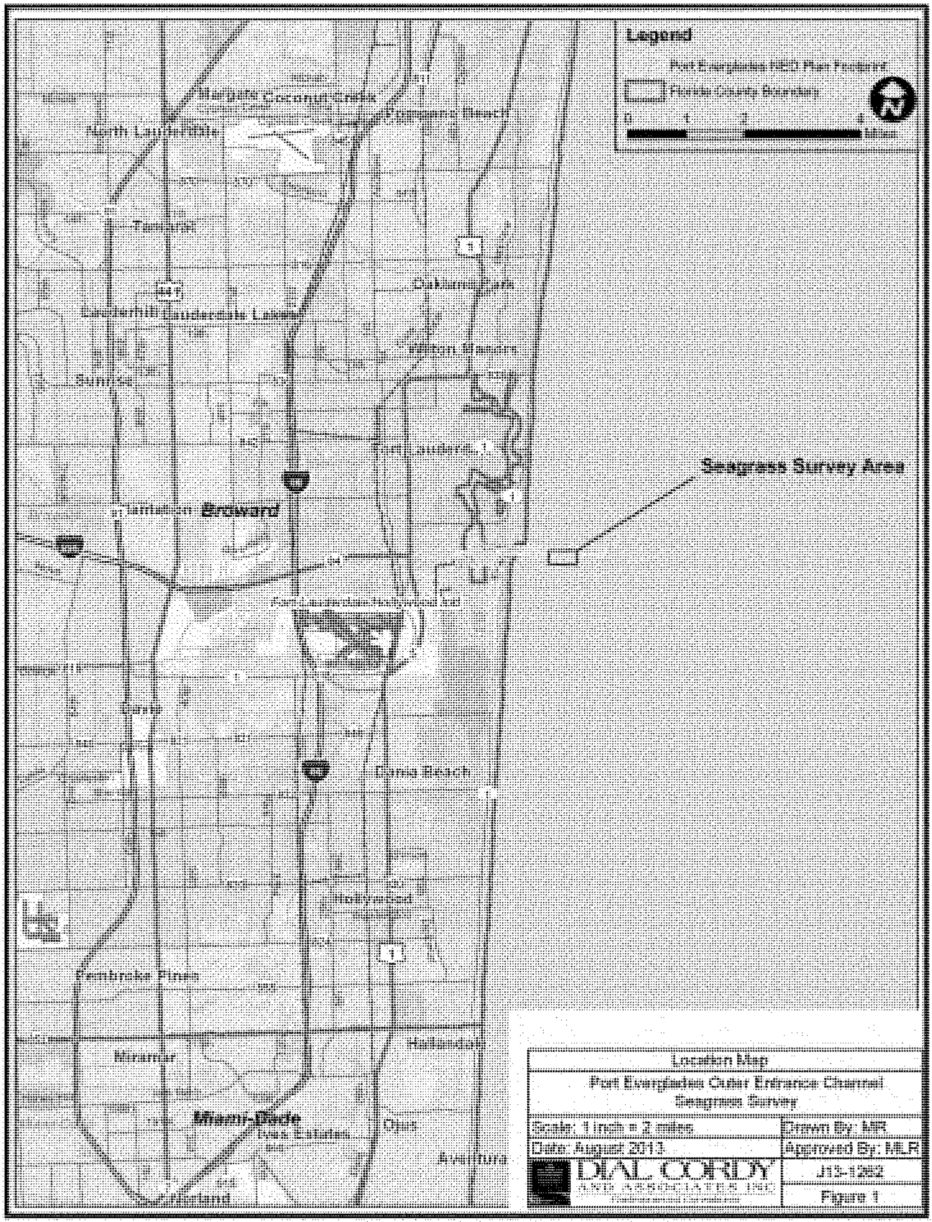
Halophila johnsonii was listed as a threatened species by National Marine Fisheries Service (NMFS) on September 14, 1998 (63 FR 49035) and a re-proposal to designate critical habitat pursuant to Section 4 of the Endangered Species Act (ESA) was published on December 2, 1998 (64 FR 64231). The final rule for critical habitat designation for *H. johnsonii* was published April 5, 2000 (Federal Register, vol. 65, No. 66). *H. johnsonii* has one of the most limited geographic ranges of all seagrass species. It is only known to occur between Sebastian Inlet and northern Biscayne Bay on the east coast of Florida (Kenworthy 1997). As stated in earlier reports (DC&A 1999) and the findings of this survey, *H. johnsonii* occurs within the Atlantic Intracoastal Waterway (AIWW) south of the turning basin for Port Everglades, in the Dania Cut-Off Canal (DCC), and within portions of the harbor area considered for federal civil works widening and deepening.

2.0 TECHNICAL APPROACH

This section describes the technical approach used to collect and analyze data associated with the environmental baseline study.

2.1 Seagrass Survey

Seagrass survey methods were consistent with the *Halophila johnsonii* Final Recovery Plan (NMFS 2002), which describes suggested survey methods for sampling *H. johnsonii*. The protocol for large sites (> 1 hectare) was used to delineate and qualitatively and quantitatively assess the seagrass bed documented by Broward County in July 2013 (NMFS 2002). The seagrass bed is located between the nearshore hardbottom and middle reef, adjacent to the southern boundary of the Port Everglades outer entrance channel.


Legend
Port Everglades NED Plan Footprint
Florida County Boundary
0
1
2
4
Miles
Seagrass Survey Area
North Lauderdale
Margate
Coconut Creek
Pompano Beach
Tamarac
Oakland Park
Lauderhill
Lauderdale Lakes
Wilton Manors
Sunrise
Fort Lauderdale
Plantation
Broward
Fort Lauderdale-Hollywood Intl
Davie
Dania Beach
Hollywood
Pembroke Pines
Hallandale
Miramar
Miami-Dade
Ives Estates
Ojus
Aventura
Norland
Location Map
Port Everglades Outer Entrance Channel
Seagrass Survey
Scale: 1 inch = 2 miles
Drawn By: MR
Date: August 2013
Approved By: MLR
DIAL CORDY
AND ASSOCIATES INC
J13-1282
Figure 1

Seagrass surveys were completed August 28-30, 2013. Weather conditions were excellent, with 0-2m seas, clear skies, and good to excellent water clarity. Underwater visibility was 25-100 feet during the seagrass survey, depending on current and tide conditions.

A tiered approach was used to delineate the seagrass bed between the nearshore hardbottom and middle reef (NMFS 2002). First, divers were towed along nine transects to delineate the boundaries of the seagrass bed. Nine transects were spaced 25m apart and oriented in a north to south direction (Figure 2). The existing channel was the northern boundary of the survey area and the southern boundary of the survey area was defined by visual observation of the end of the seagrass bed. In order to gain an understanding of the dimensions of the seagrass bed, which was initially reported to be large, towed divers with communications between the divers and the topside vessel were used. Divers were towed on a line, set back 50 feet (15 meters) from the vessel. Divers were towed at <1 knot and maintained a depth of approximately 1m above the bottom. Divers were able to control depth using a planar board and could descend to look closely at the benthic community in order to identify seagrass species. A tenth transect was surveyed to document the presence of a seagrass bed that had been previously documented west of the nearshore hardbottom (Figure 2).

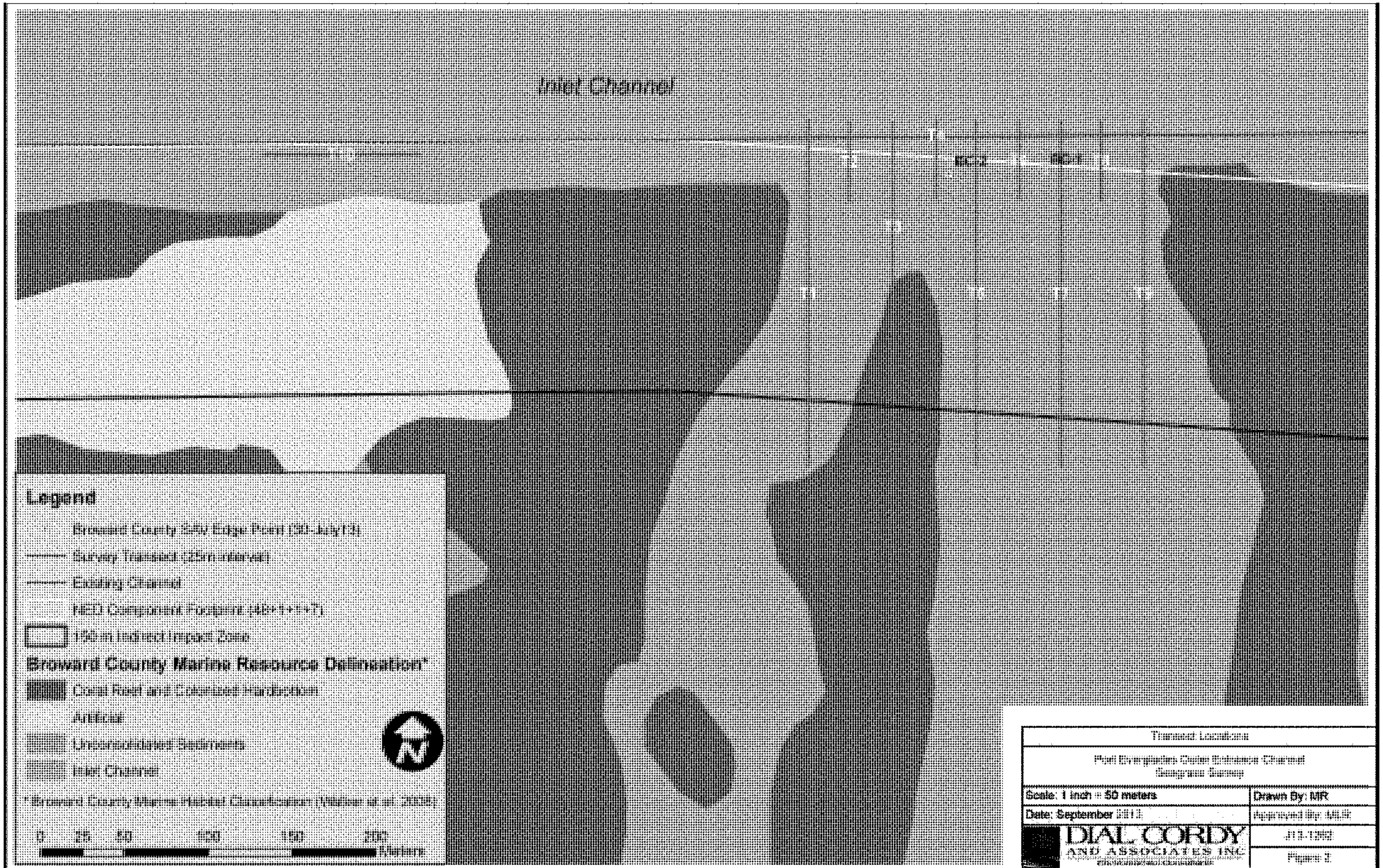
After the towed divers delineated the extent of the seagrass bed between the nearshore hardbototm and middle reef, divers were deployed to photograph and quantitatively survey the seagrass bed at two locations, BB1 and BB2 (Figure 3).

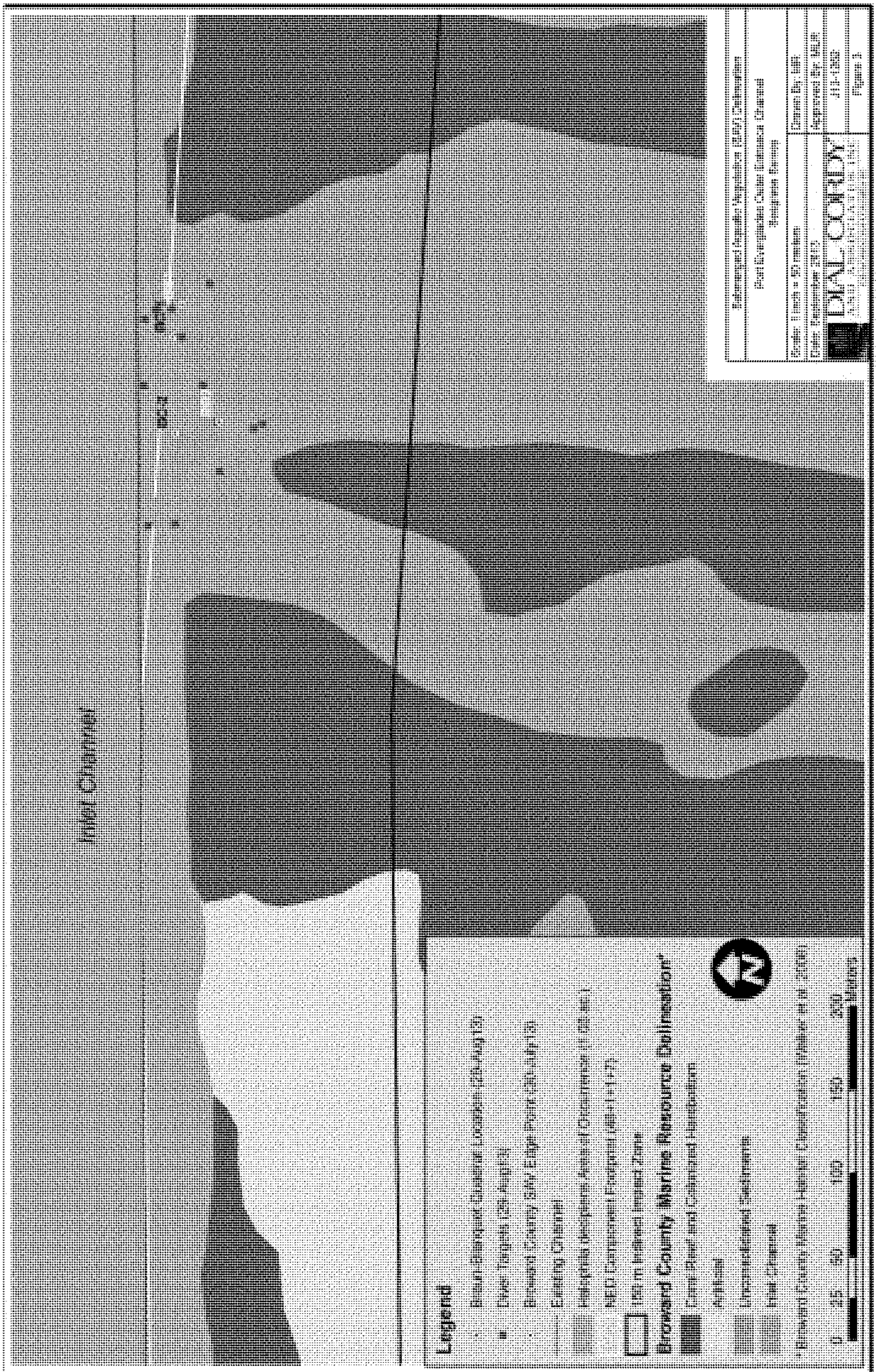
2.1.1 Seagrass Occurrence, Abundance, and Density

To obtain biological data regarding the occurrence, abundance, and density of marine seagrass, $1m^2$ quadrats were deployed in two locations (BB1 and BB2). The chosen sampling locations were identified during transect surveys as areas of the highest density and greatest continuous seagrass. Fifteen quadrats were sampled at BB1 and 13 quadrats were sampled at BB2. Specific data recorded within each $1m^2$ quadrat for each seagrass species present included the number of sub-units (100 possible) containing at least one shoot, an average cover abundance score (Braun-Blanquet 1965), a description of substrate type, and any other observations considered useful (Virnstein 1995; Fonseca et al. 1998; Braun-Blanquet 1965). The cover abundance scale is discussed below.

The scale values are:

0.1 = Solitary shoots with small cover
0.5 = Few shoots with small cover
1.0 = Numerous shoots but less than 5% cover
2.0 = Any number of shoots but with 5-25% cover
3.0 = Any number of shoots but with 25-50% cover
4.0 = Any number of shoots but with 50-75% cover
5.0 = Any number of shoots but with >75% cover


Inlet Channel
Legend
Broward County S/W Edge Point (30-July13)
Survey Transect (25m interval)
Existing Channel
NED Component Footprint (48+1+1+7)
150 m Indirect Impact Zone
Broward County Marine Resource Delineation*
Coral Reef and Colonized Hardbottom
Artificial
Unconsolidated Sediments
Inlet Channel
* Broward County Marine Habitat Classification (Walker et al. 2008)
0 25 50 100 150 200
Meters
Transect Locations
Port Everglades Outer Entrance Channel
Seagrass Survey
Scale: 1 inch = 50 meters
Drawn By: MR
Date: September 2013
Approved By: MLR
DIAL CORDY
AND ASSOCIATES INC
Figure 3


Inlet Channel
Legend
Broward County Marine Resource Delineation
0 25 50 100 150 200 Meters
N

From the survey of quadrats, frequency of occurrence, abundance, and density of seagrass was computed as follows:

Frequency of occurrence = Number of occupied sub-units/total number of sub-units
Abundance = Sum of cover scale values/number of occupied quadrats
Density = Sum of cover scale values/total number of quadrats

2.1.2 Analysis and Interpretation of Seagrass Data

Distribution of the seagrass community was mapped for each transect from the diver identified edge of bed data, that was collected using a towed diver and communications equipment. Frequency of occurrence, abundance, and density were calculated from the quadrat data based on Braun-Blanquet (1965) methodology.

3.0 RESULTS

3.1 Seagrass Species Frequency of Occurrence, Abundance, and Density at Two Locations

Marine seagrass species observed within the study area included *Halophila decipiens*, no other seagrass species were found. No *Halophila johnsonii* was documented (Figure 3). In general, the *H. decipiens* bed was sparse to moderately dense, with density of seagrass decreasing from east to west. Data sheets are included as Appendix B.

At the two locations sampled, *H. decipiens* had a frequency of occurrence of 0.44 and 0.31 out of a possible 1.0 (Table 1).

Abundance and density values were the same in this case because the total number of quadrats sampled was the same as the total number of occupied quadrats sampled. Abundance and density for BB1 was 1.86 and 1.69 for BB2. Figure 4 and 5 show sample quadrats at BB2, a complete record of photos can be found in Appendix A.

3.2 Seagrass Bed Area Calculations

An estimated 1.03 acres of seagrass occurs between the nearshore hardbottom and middle reef. An estimated 0.20 acre of this area lies within the project footprint and may be impacted by the planned deepening and widening of Port Everglades.

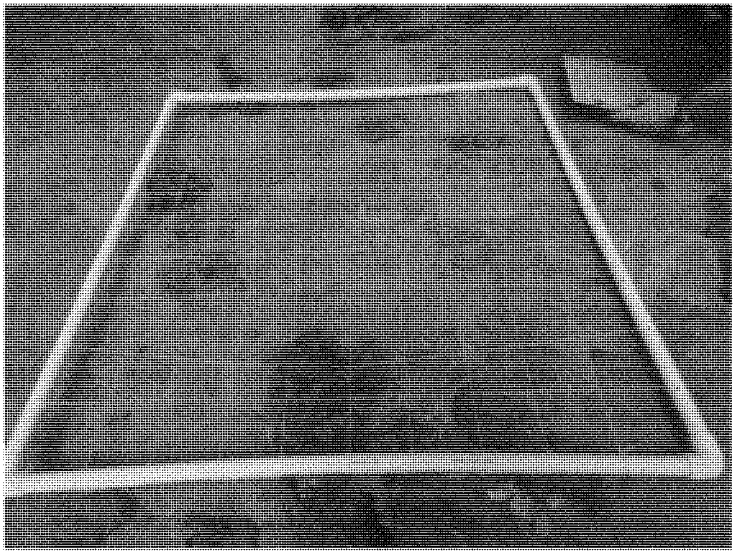


Figure 4 Sparse *Halophila decipiens* within $1m^2$ quadrat at BB2.

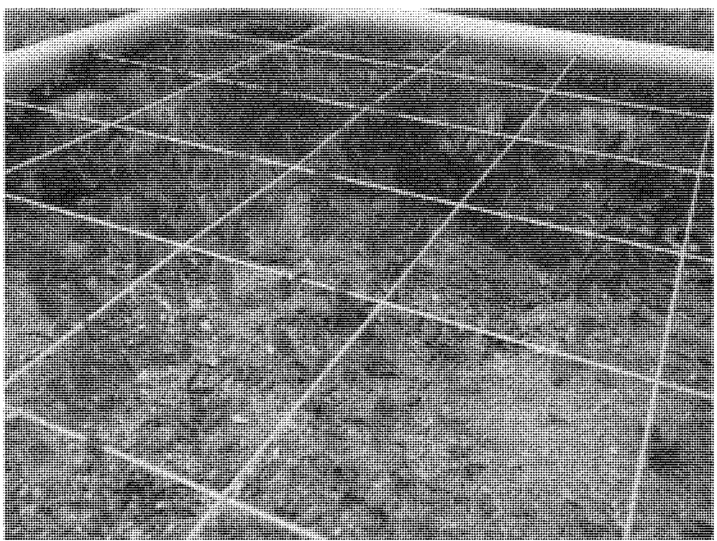


Figure 5 *Halophila decipiens* within a sample quadrat at BB2.

3.3 Seagrass Bed West of Nearshore Hardbottom

An *H. decipiens* seagrass bed persists west of the seagrass bed between the nearshore hardbottom and middle reef along Transect 10 (Figure 3). *H. decipiens* was sparse here and due to diver safety, no quadrat data were collected in this location. This seagrass bed is outside of the proposed project footprint.

Table 1 *Halophila decipiens* Frequency of Occurrence, Abundance, and Density Values between nearshore and middle reef.

	Frequency	Abundance	Density
BB 1	0.44	1.86	1.86
BB 2	0.31	1.69	1.69

4.0 DISCUSSION

Seagrasses in the vicinity of Port Everglades have been documented since the late 1990s (DC&A 2009). Most seagrass in the vicinity are located in shallow water (1-20 feet), within the AIWW and Dania Cutoff Canal (DCC) as well as in the turning basin and inner entrance channel. This survey conducted in August 2013 documented a 1.03 acre *H. decipiens* bed between the nearshore hardbottom and middle reef on the south side of the outer entrance channel in 35-40 feet of water.

H. decipiens is known to occur in offshore waters of south Florida as deep as 50 feet (Williams 1988). *H. decipiens* beds within the outer entrance channel and adjacent to the outer entrance channel have been documented in the past by Dial Cordy and Associates and Broward County (DC&A 2009; Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County). The occurrence of this seagrass bed is not unusual considering the natural distribution of the species and the history of seagrasses within the area.

The 1.03 acres of *H. decipiens* documented during the August 2013 survey includes 0.20 acre of seagrass that may be impacted by the deepening and widening project. Seagrass mitigation may be required for this acreage.

5.0 REFERENCES

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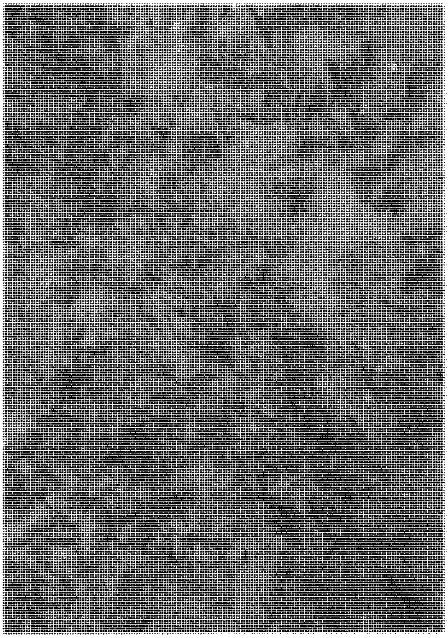
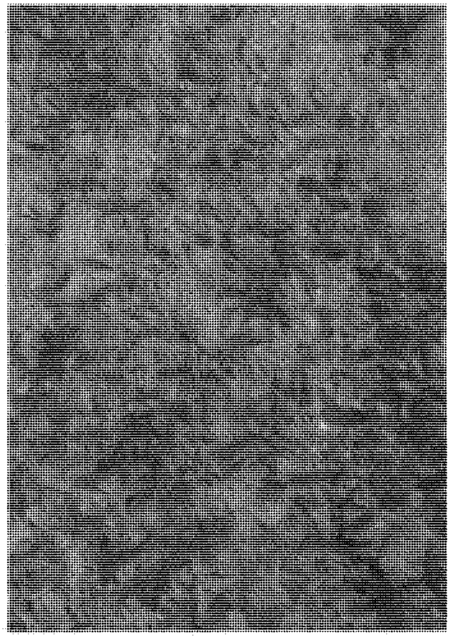
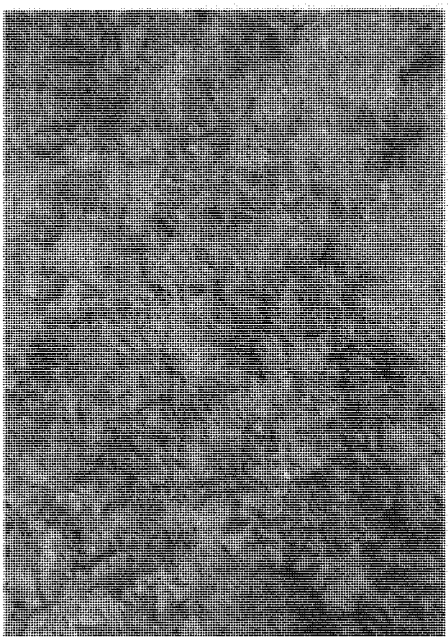
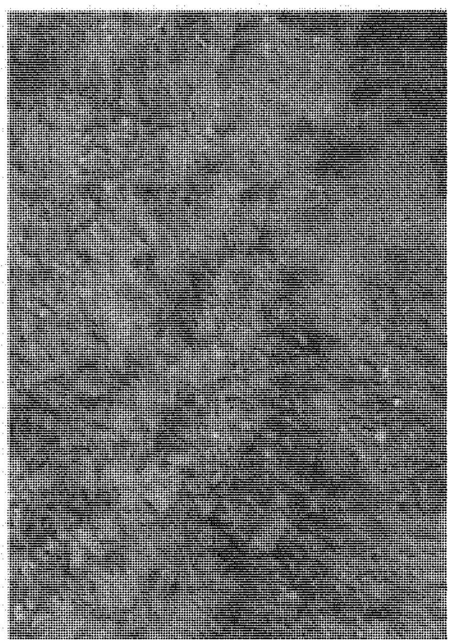
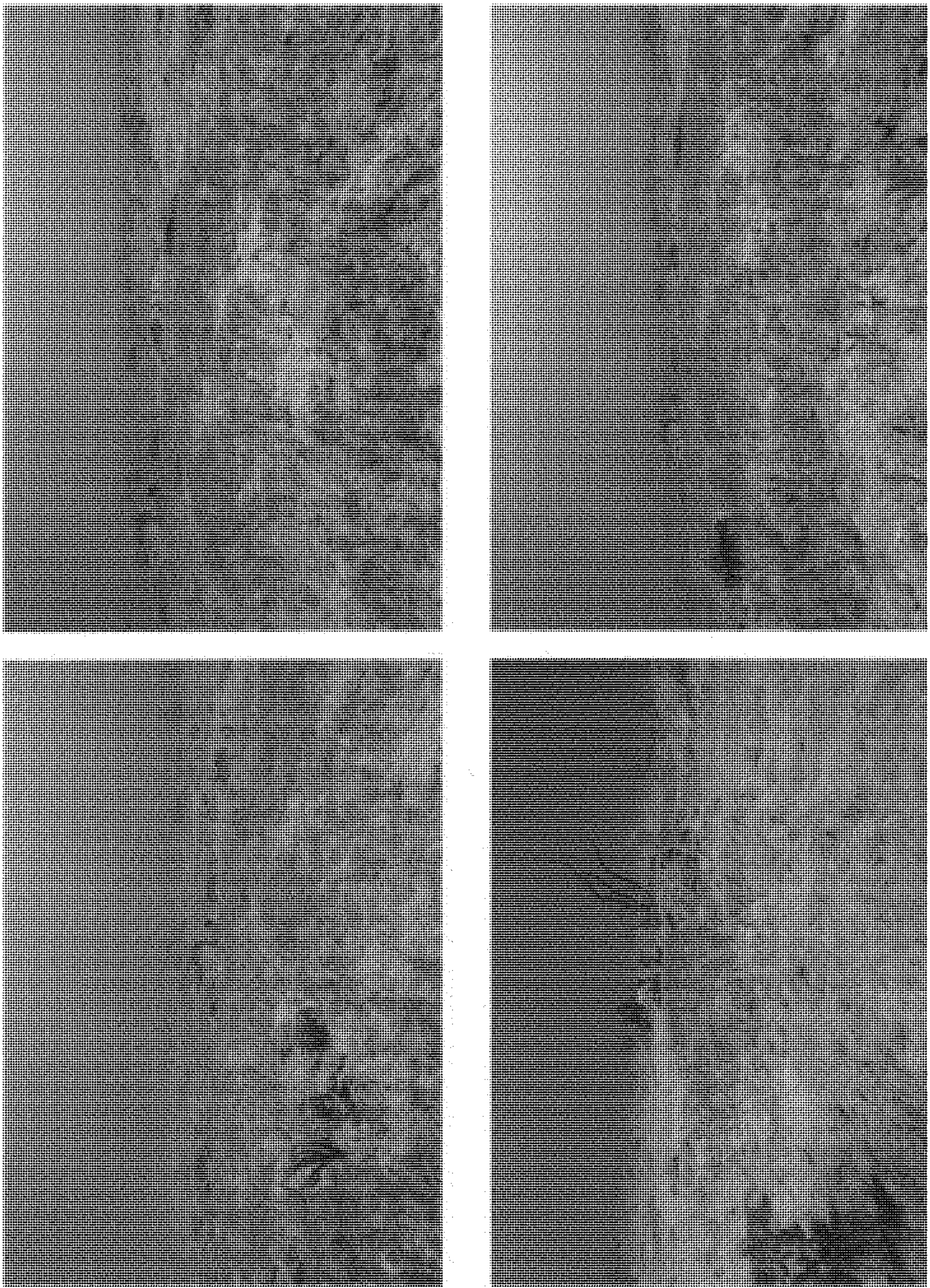
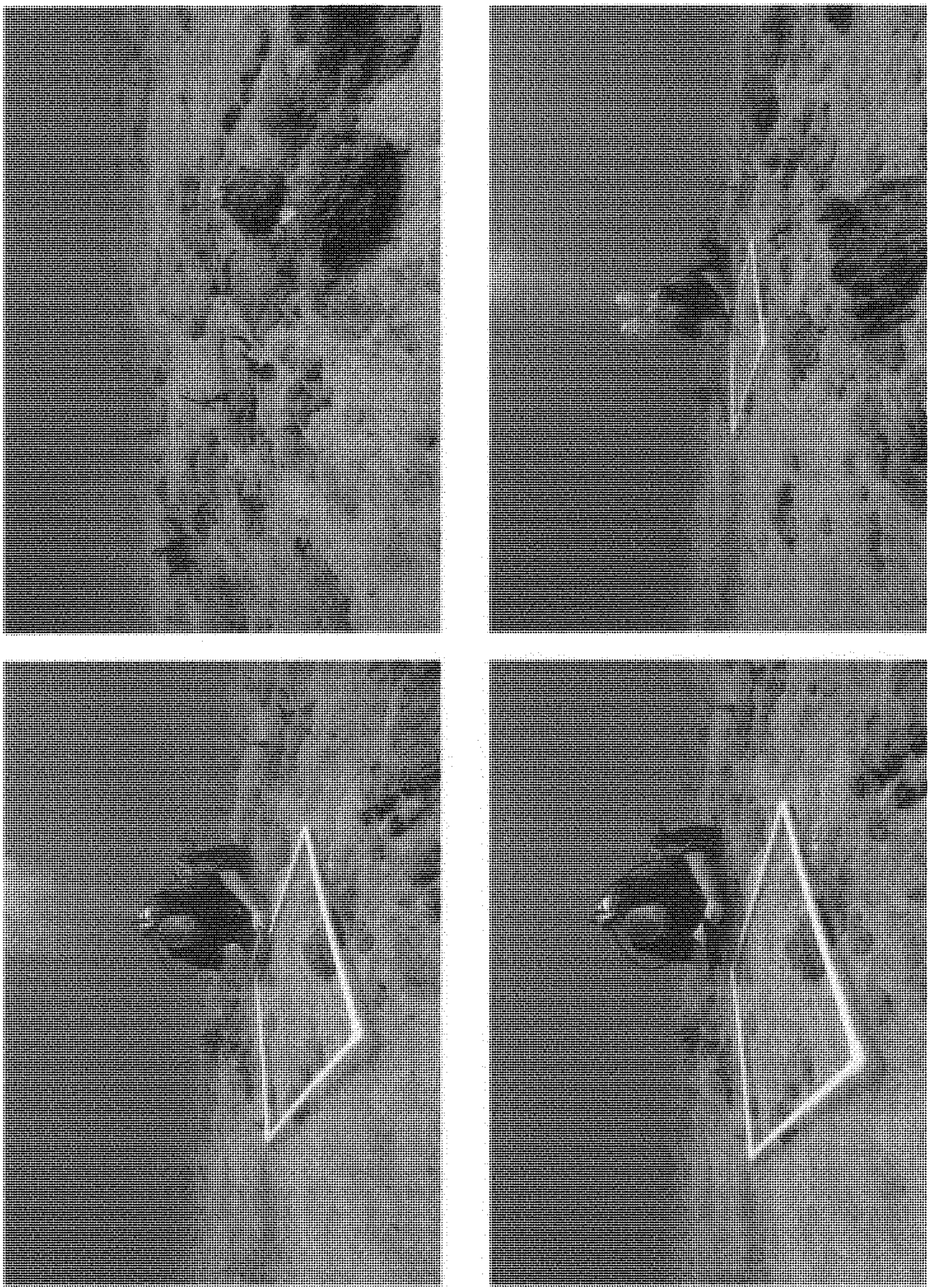
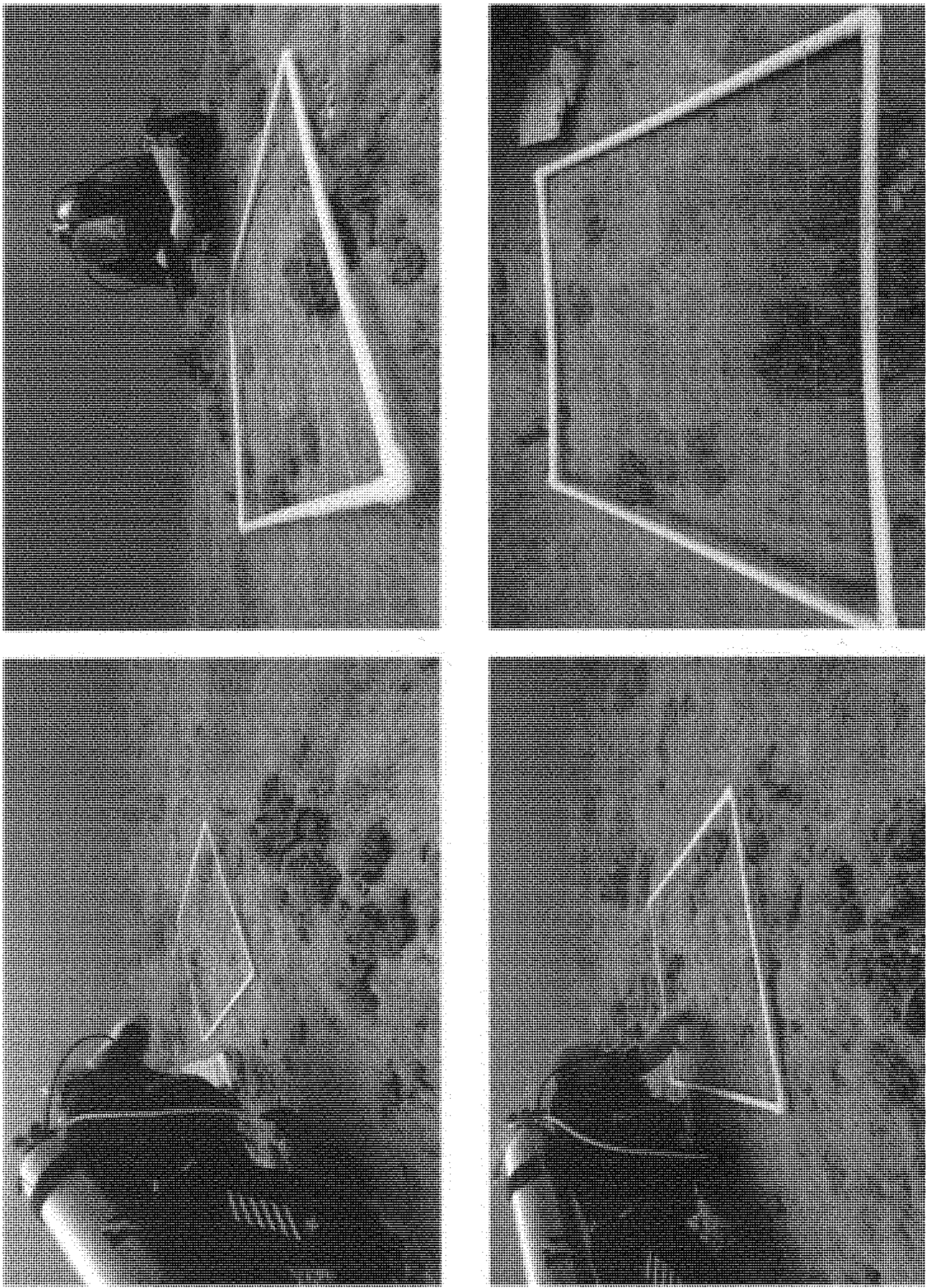
APPENDIX A

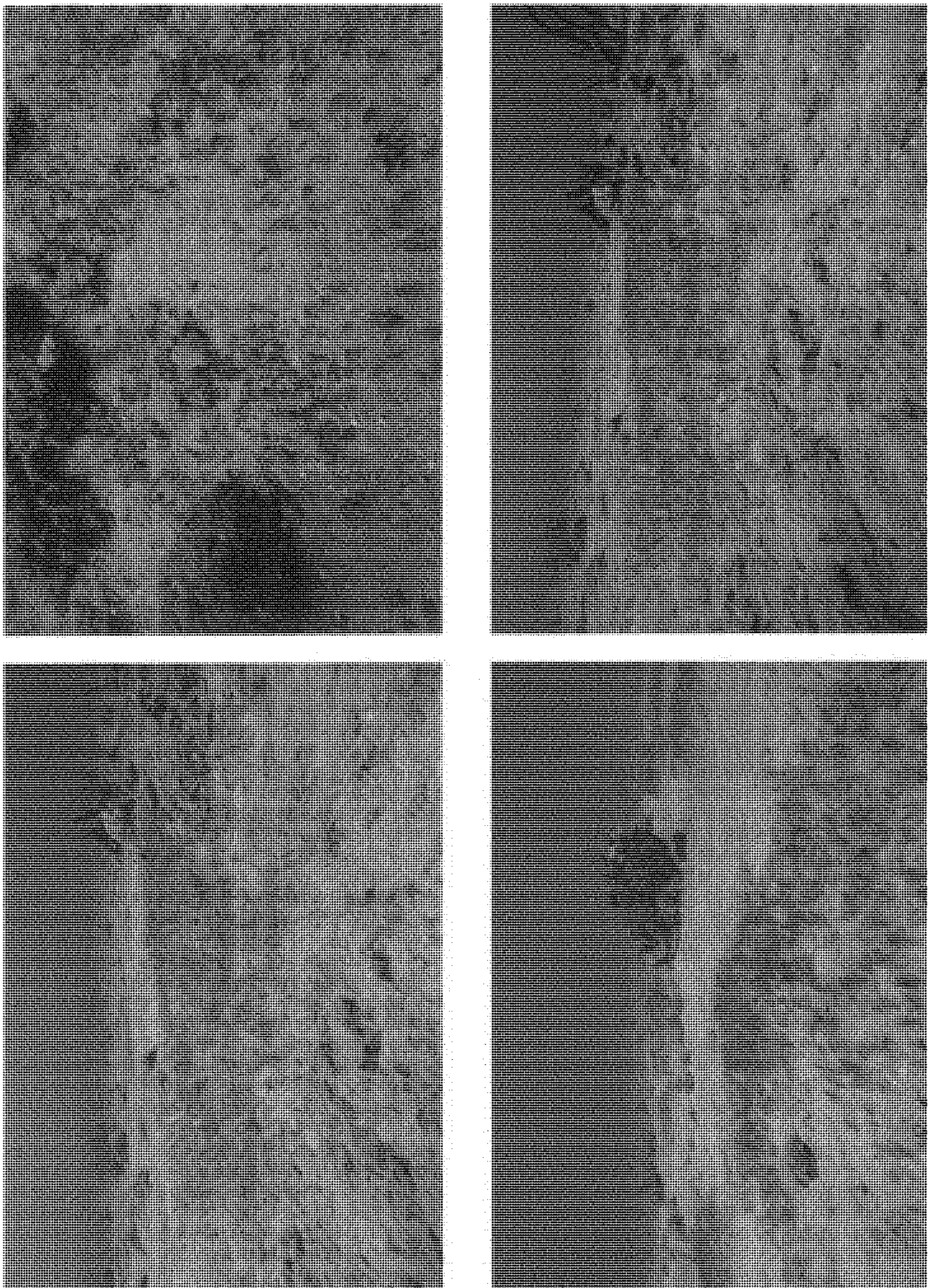
Photographs

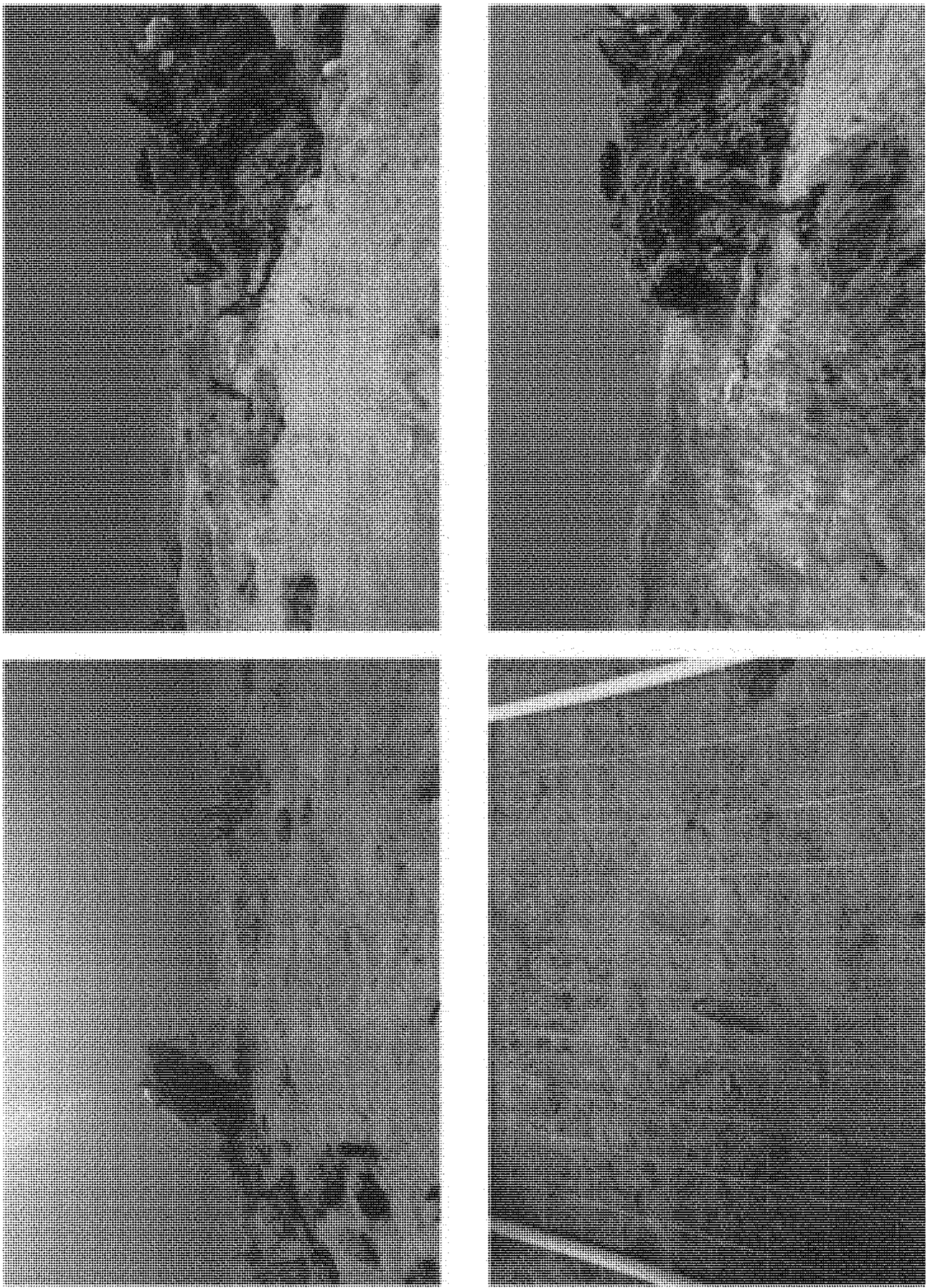





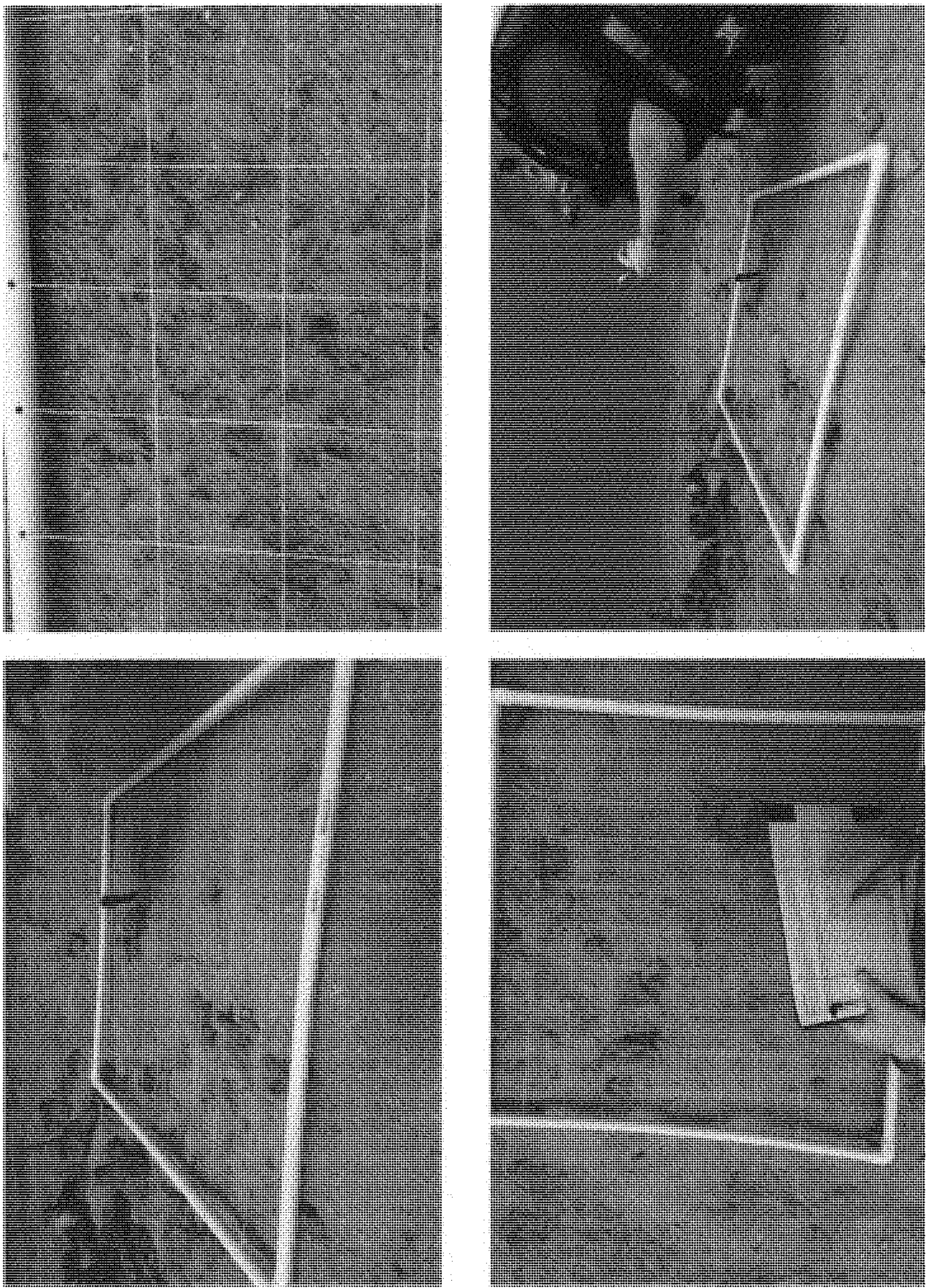


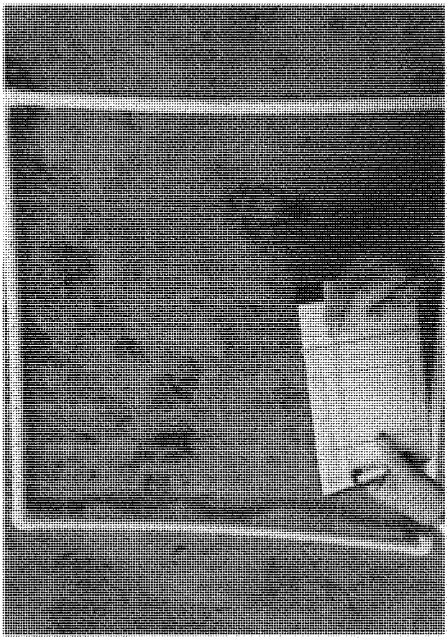
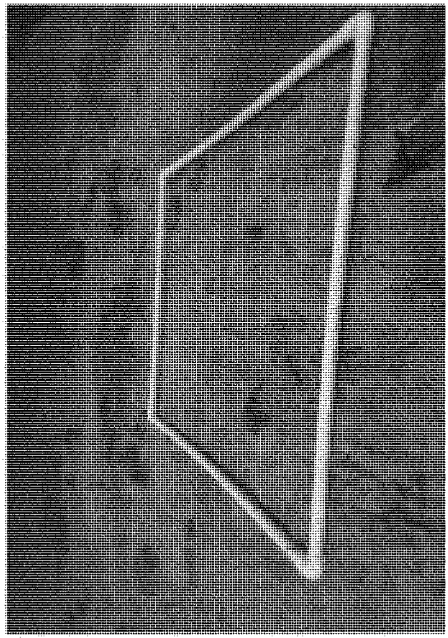
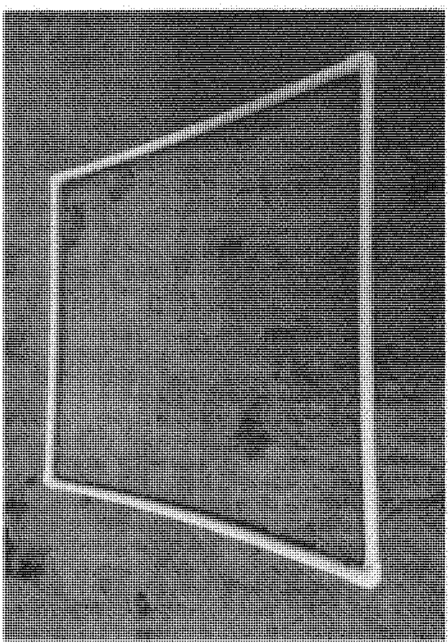
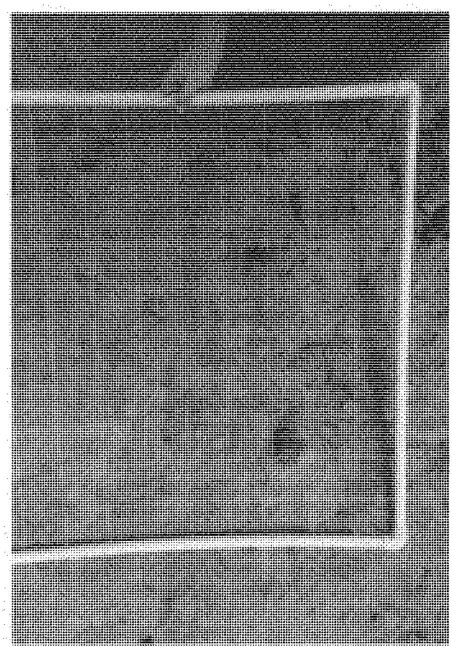


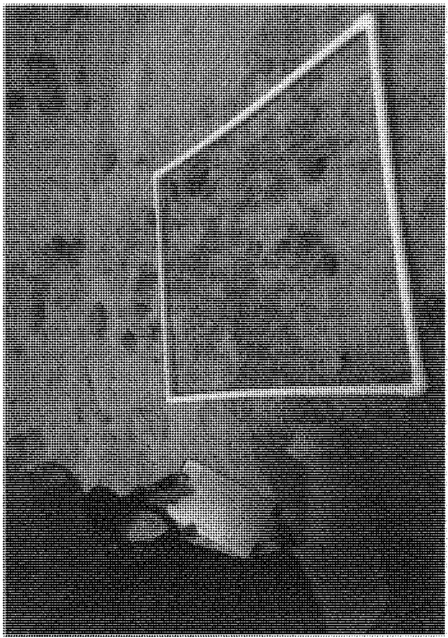


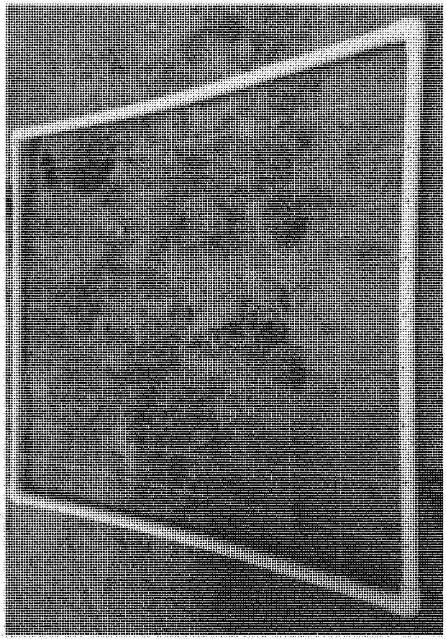


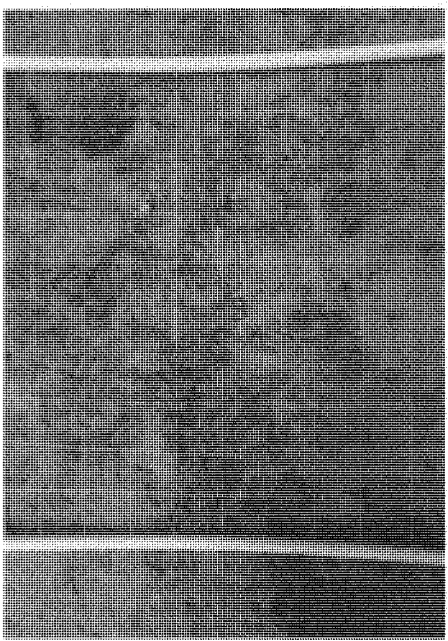


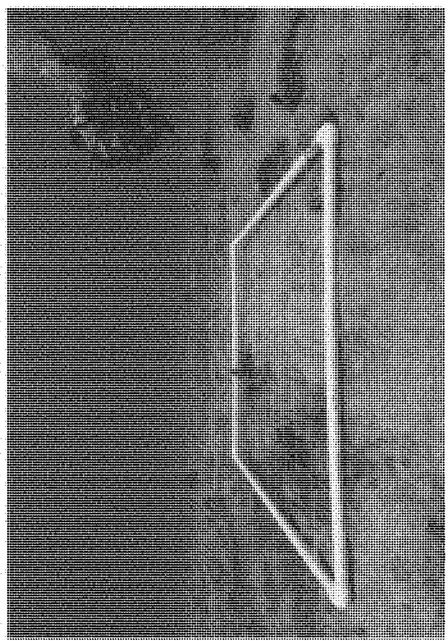


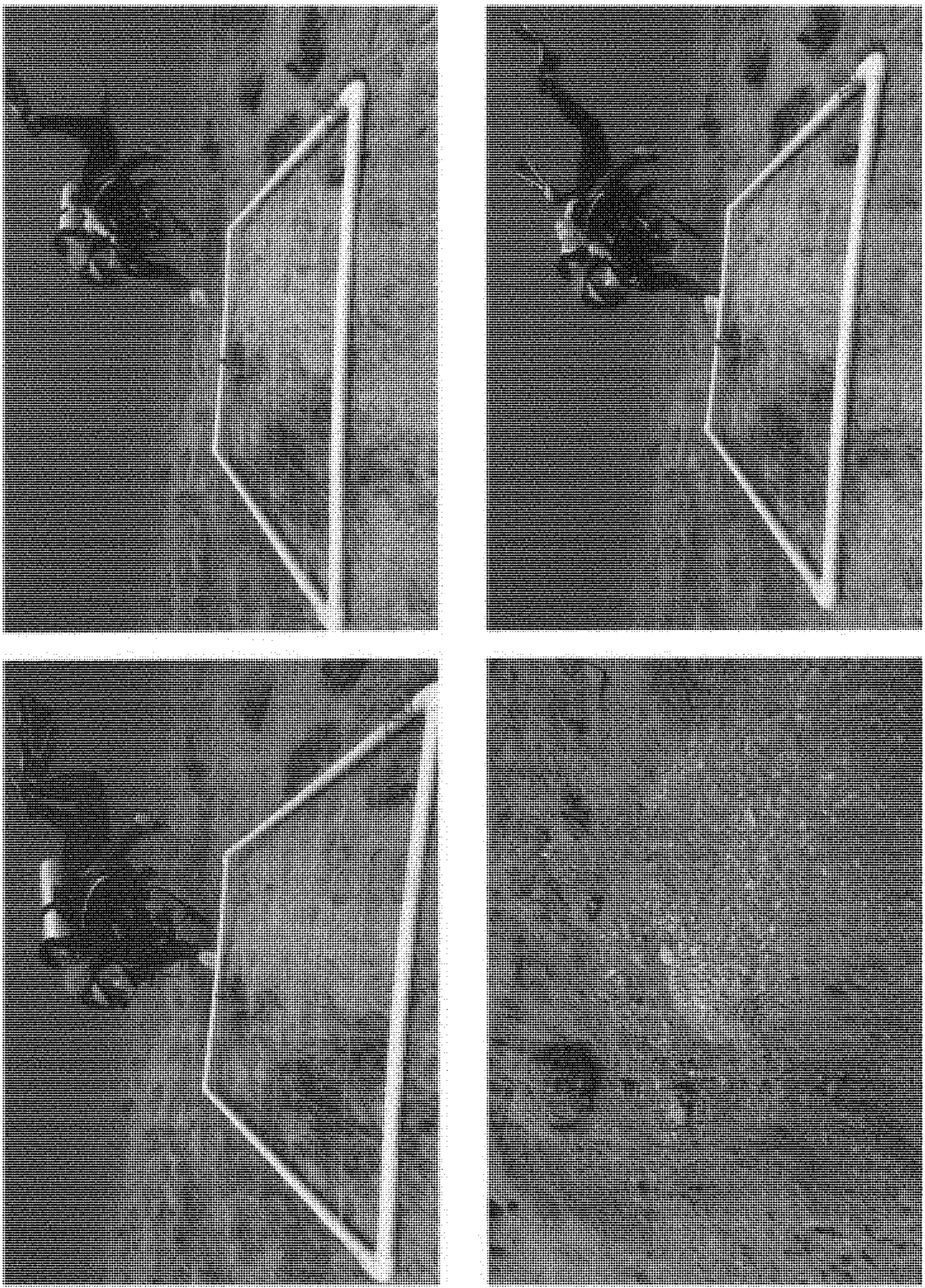





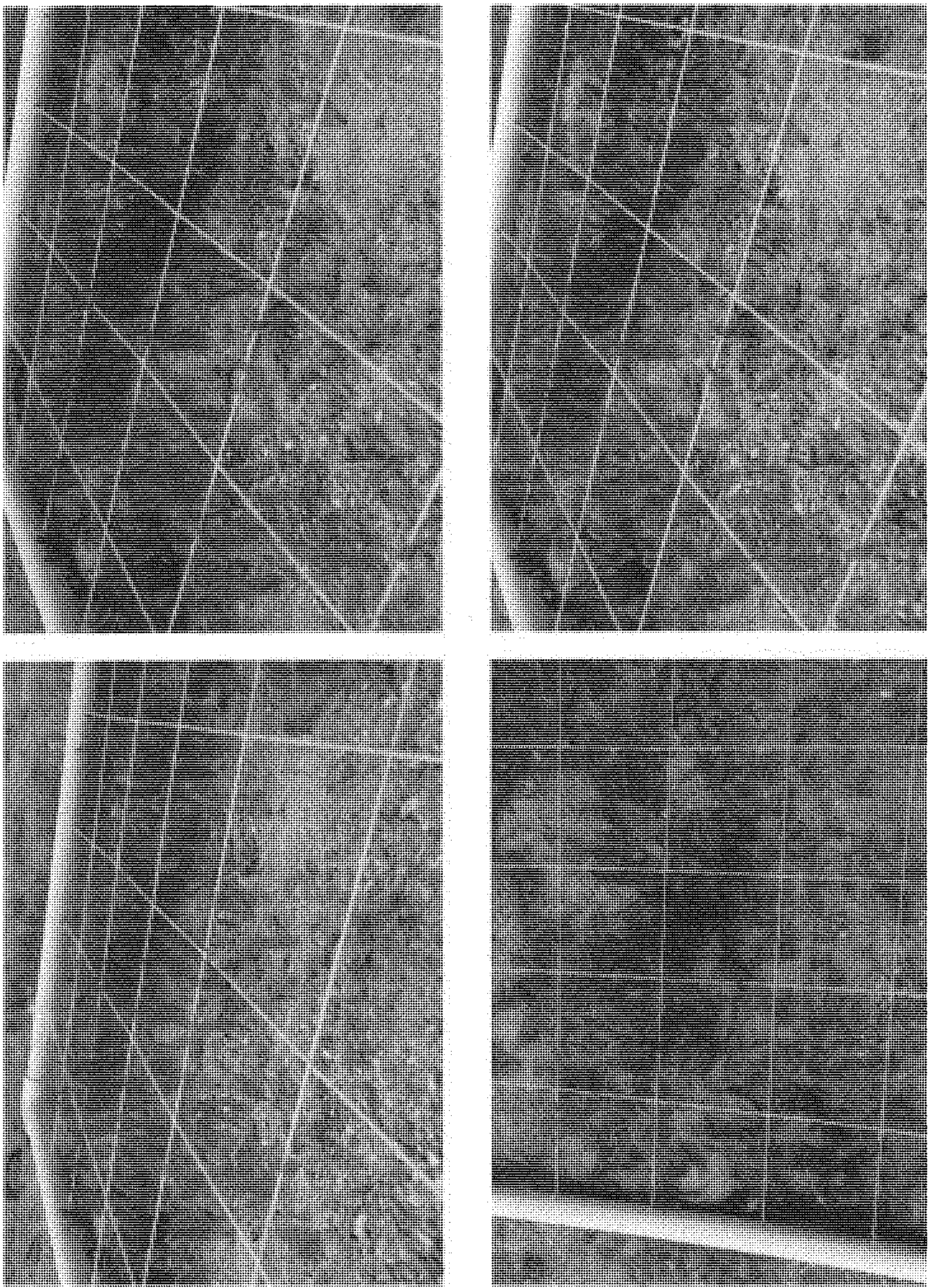


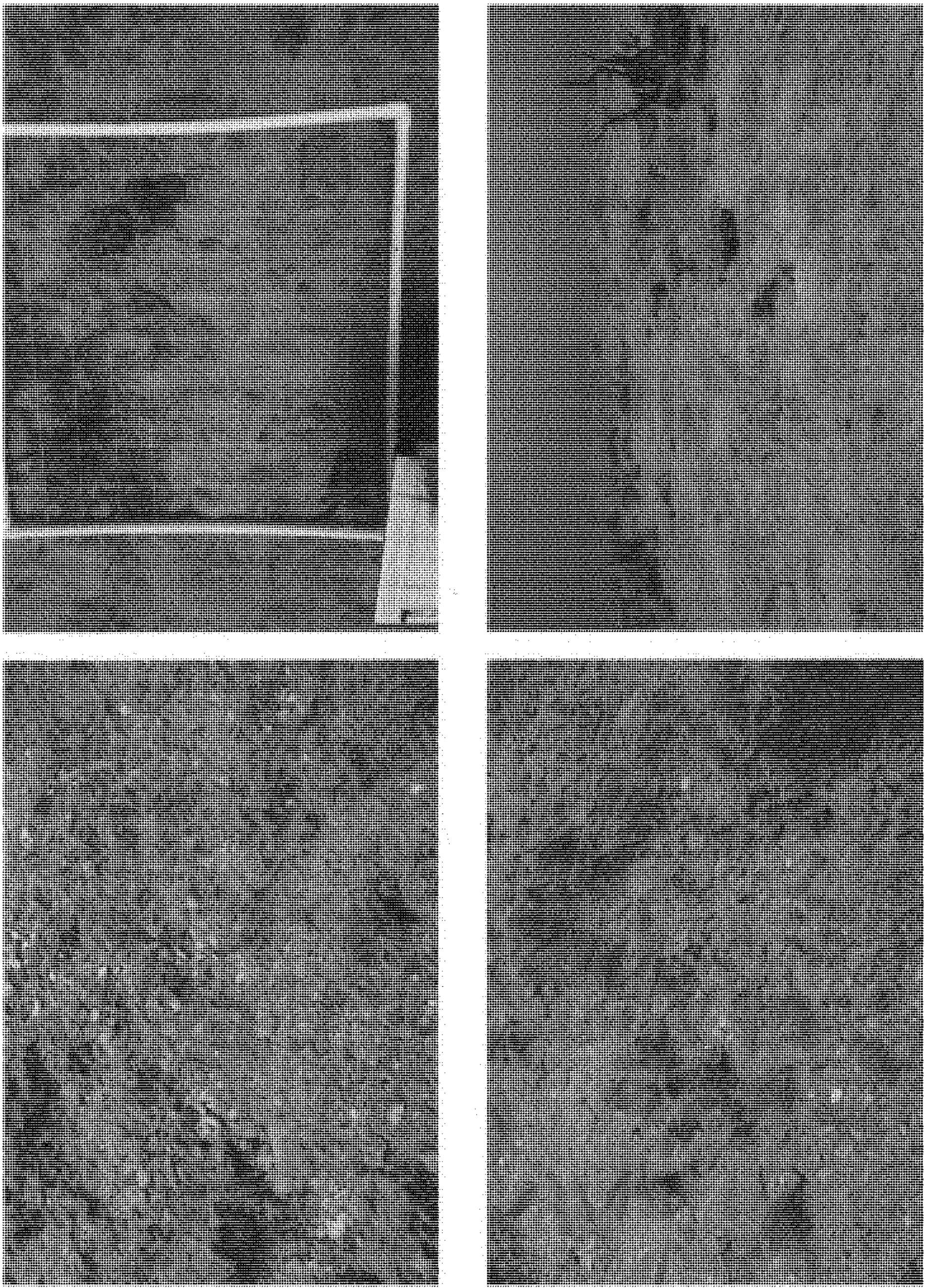


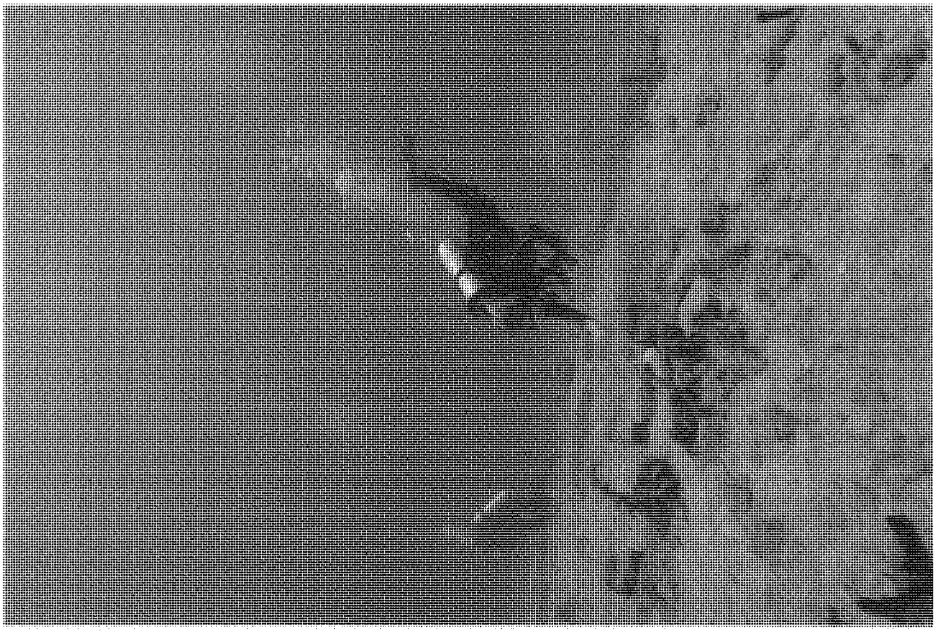


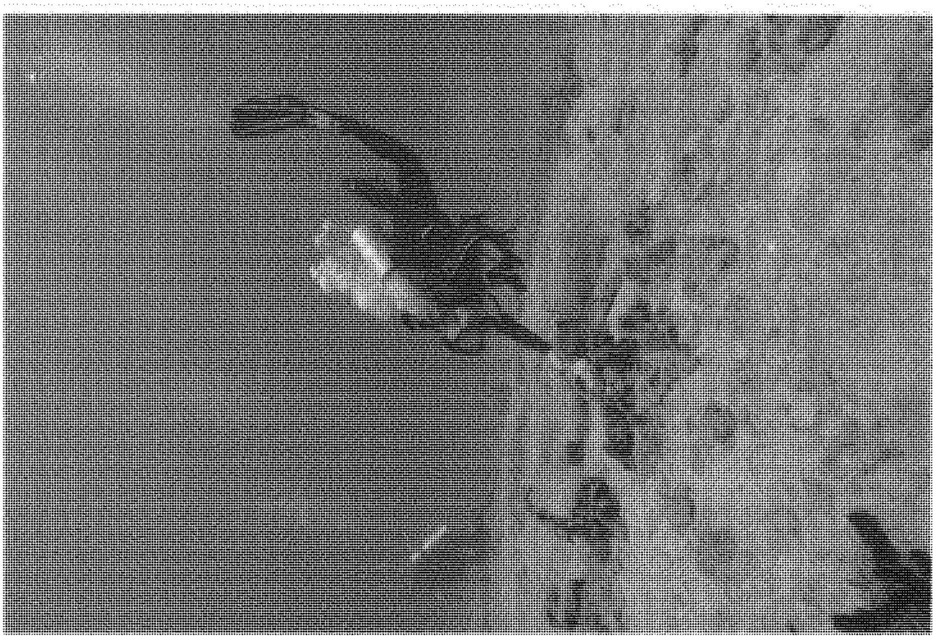


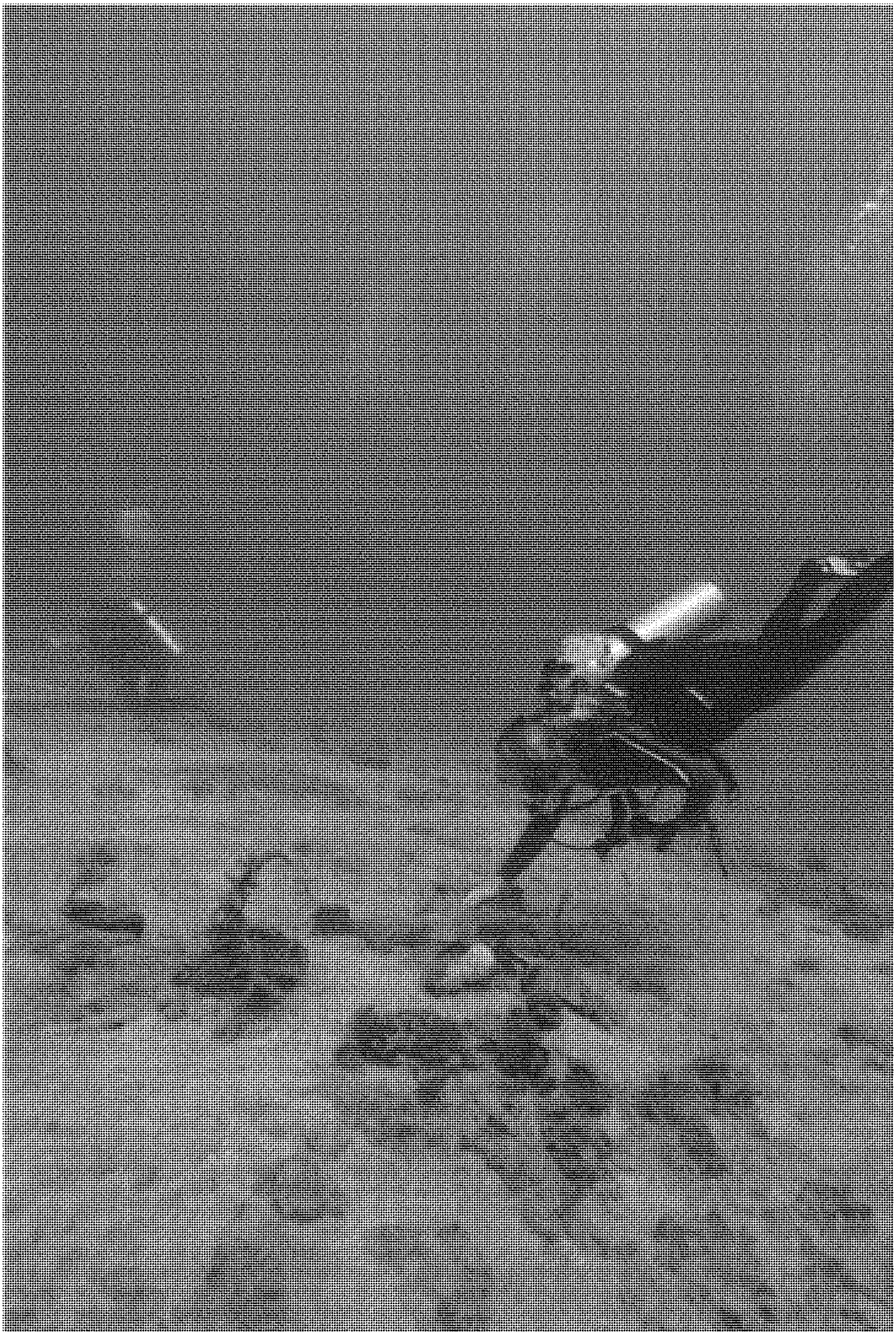


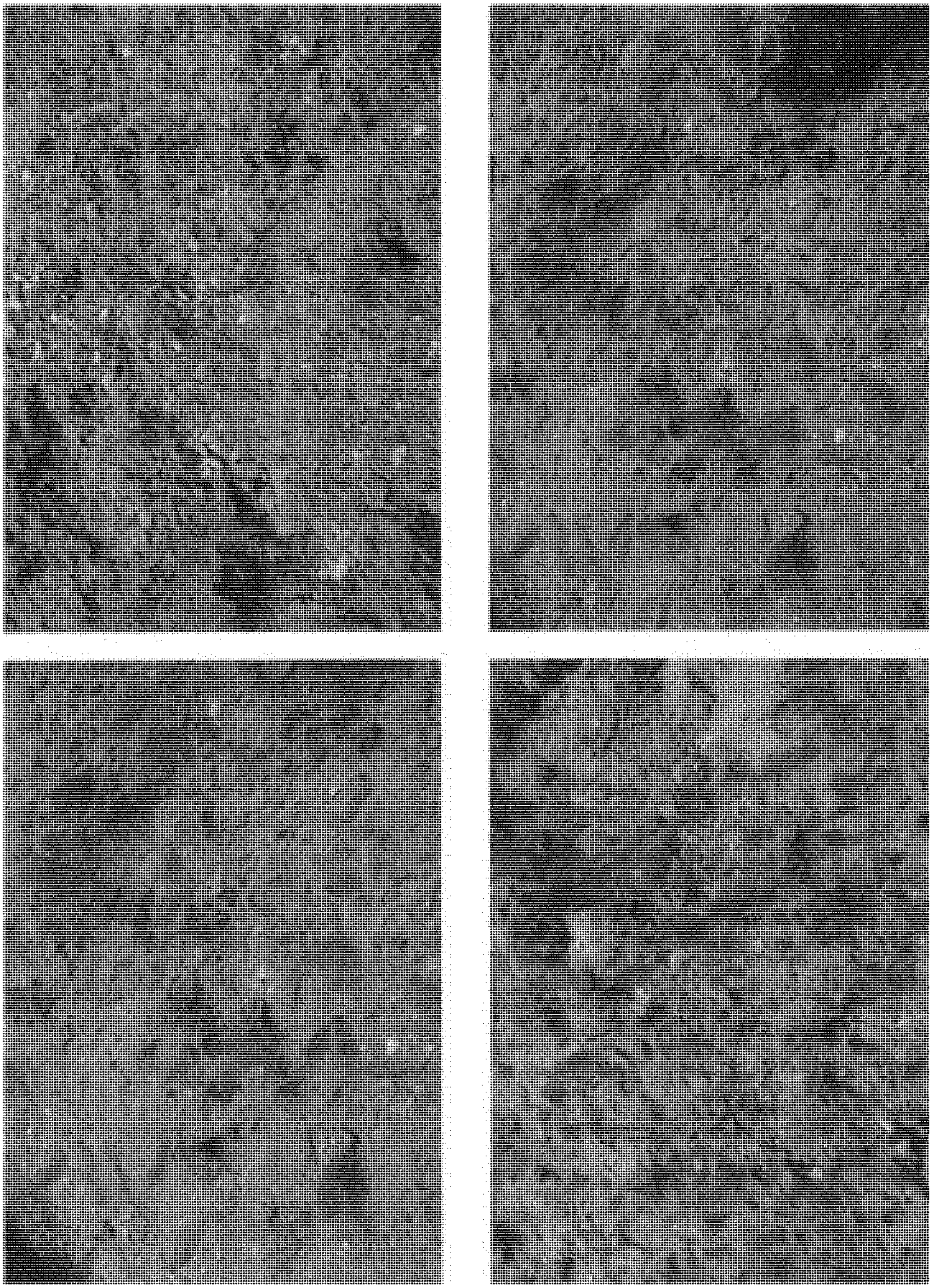


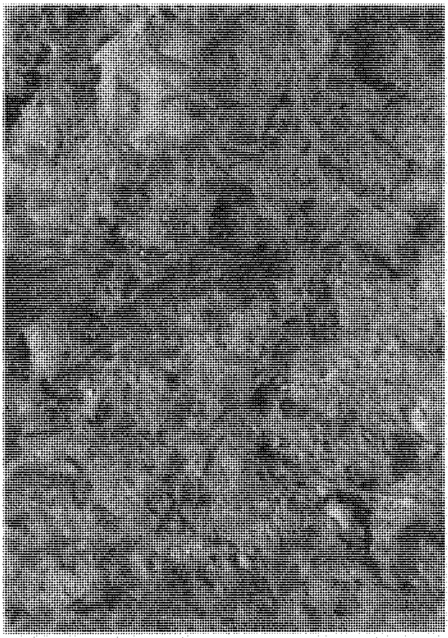


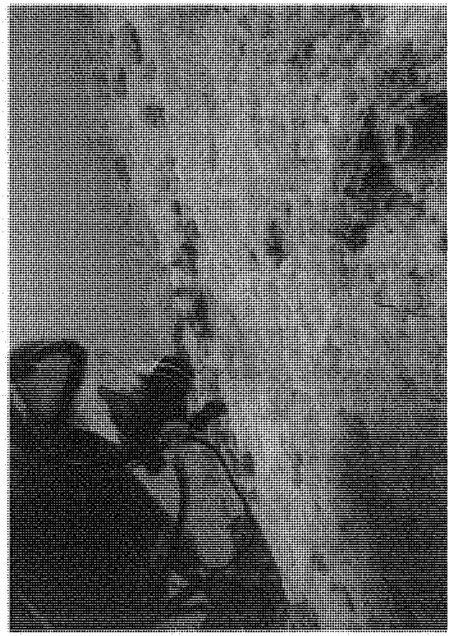


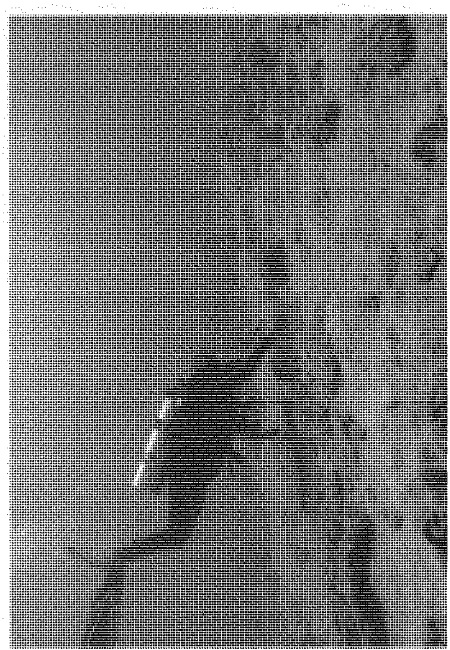


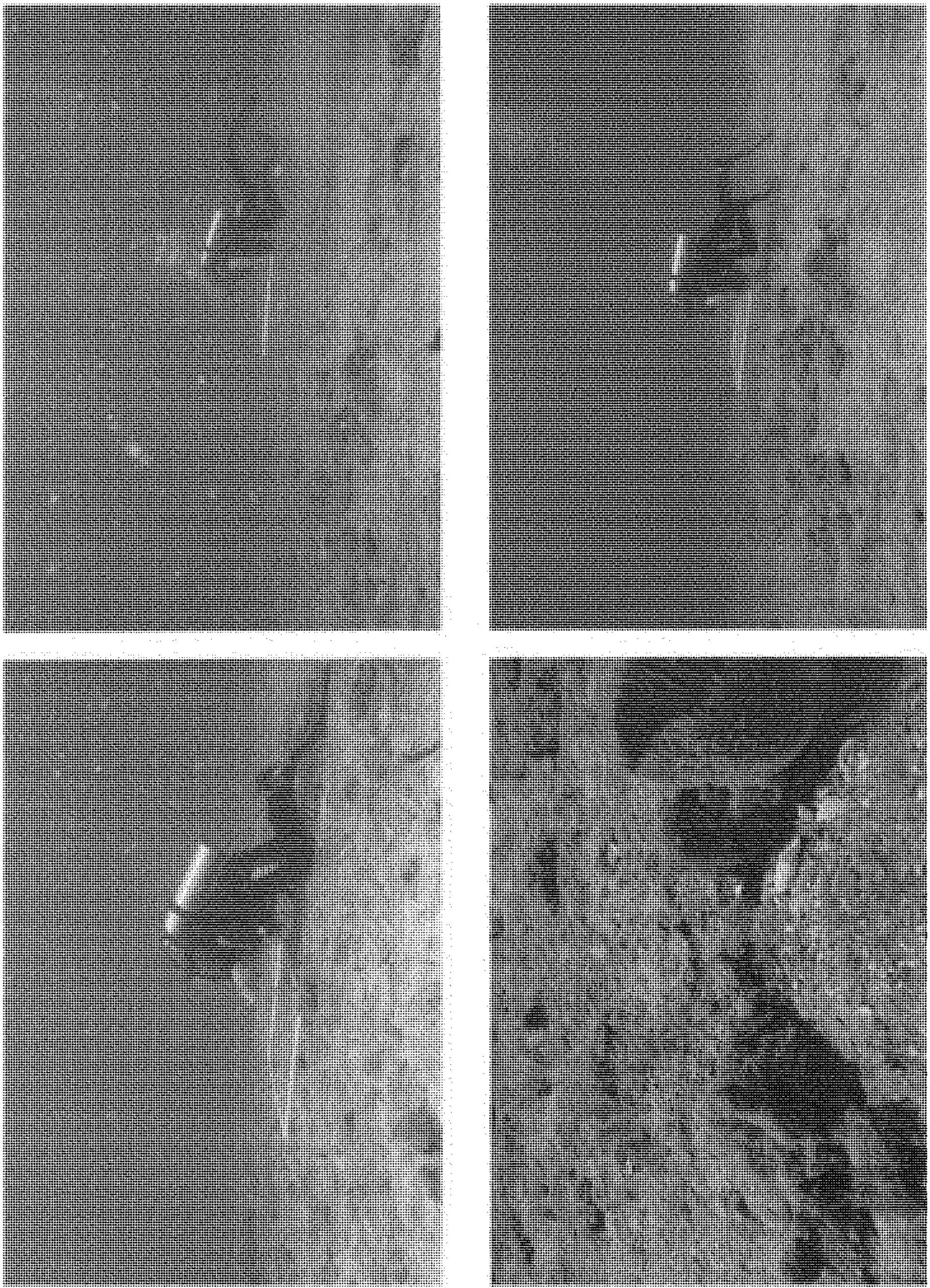












APPENDIX B

Data Sheets

Seagrass Data Sheet Job# 1262 | Compass heading: | Tide Start: | Tide End:

Date 8/28/13 | Site (Transect #) BB | Crew: | Weather: fair seas clear water

Species: (HW) Halodule wrightii, (R) Ruppia, (TT) Thalassia, (S) Syrigodium, (HD) Halophila decipiens, (AA) attached algae, (DA) drift algae

Abundance: r = solitary, + = few, 1 = < 5% cover, 2 = 5-25% cover, 3 = 26-50% cover, 4 = 51-75% cover, 5 = 76-100% cover

Epiphyte density: 1=clean, 2=light, 3=moderate, 4=heavy

Site Comments:

Sediments: 1=shelly sand, 2=sand, 3=muddy sand, 4=muck

Line Intercept:

Station (m)	Time	Depth (cm)	Species	Abundance	Quads Occupied	Blade Length (5)	Epiphyte Density	Epiphyte desc.	Sediment	Station Comments
1		45	Hd	1	28	2-3 cm			Sand w/ rubble	
2		43	"	3	84	"			Sand	
3		44	"	3	22	"			"	
4		44	"	1	10	"			Sand + Rubble	
5		44	"	2	70	"			"	
6		44	"	2	63	"			"	Freq: 662/1500 = 0.44
7		44	"	3	85	"			"	
8		43	"	2	60	"			"	
9		43	"	1	12	"			"	abund: 28/15 = 1.86
10		43	"	P	7	"			"	
11		43	"	1	23	"			"	
12		43	"	3	79	"			"	density: 28/15 = 1.86
13		44	"	2	22	"			"	
14		44	"	1	6	"			"	
15		43	"	2	31	"			"	
				28	662					
				15	4444					
			abundance 1.86		0.44 = 44% cover					

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Seagrass Data Sheet	Job# 1262	Compass heading:	Tide Start:	Tide End:
Date 8/30/13	Site (Transect #) BB2	Crew:		Weather: excellent seas + skies

Species: (HW) Halodule wrightii, (R) Ruppia, (TT) Thalassia, (S) Syrigodium, (HD) Halophila decipiens, (AA) attached algae, (DA) drift algae

Abundance: r = solitary, + = few, 1 = < 5% cover, 2 = 5-25% cover, 3 = 26-50% cover, 4 = 51-75% cover, 5 = 76-100% cover

Epiphyte density: 1=clean, 2=light, 3=moderate, 4=heavy

Sediments: 1=shelly sand, 2=sand, 3=muddy sand, 4=muck

Site Comments:

Line Intercept:

Station (m)	Time	Depth (cm)	Species	Abundance	Quads Occupied	Blade Length (5)	Epiphyte Density	Epiphyte desc.	Sediment	Station Comments
1		45	Hd	1	11	2 cm	0		Sand w/ rubble	
2		45	"	3	78	"			"	
3		46	"	1	16	"			"	
4		46	"	1	6	"			"	
5		46	"	1	12	"			"	
6		46	"	4	83	"			"	F: 408/1300 = 0.31
7		45	"	2	42	"			"	
8		45	"	3	83	"			"	A = 22/13 = 1.69
9		45	"	2	28	"			"	
10		45	"	1	13	"			"	
11		45	"	1	15	"			"	D: 22/13 = 1.69
12		45	"	1	8	"			"	
13		44	"	1	13	"			1	
				22	408					
			1.69 = abundance		408/1300 = 0.31 or 31% cover					

EIS
SUB-APPENDIX E

MITIGATION AND MONITORING PLAN

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

Port Everglades Harbor Navigation Study Comprehensive Mitigation Plan and Incremental Cost Analysis

Prepared for

Jacksonville District
U.S. Army Corps of Engineers
Jacksonville, Florida

by

Dial Cordy and Associates Inc.
Jacksonville Beach, Florida

With selected content provided by

NOAA Fisheries
a Cooperating Agency under the National Environmental Policy Act

6 March 2015

PREFACE

In accordance with Section C-3(b)(12)(e) of ER-1105-2-100 (ER-100), mitigation opportunities were considered to compensate for effects caused by the proposed project at Port Everglades (Ft. Lauderdale, Florida). The Jacksonville District U.S. Army Corps of Engineers (USACE) commenced mitigation investigations early in the feasibility phase of the study (1998), including attempts to minimize impacts, estimating unavoidable potential impacts, considering potential mitigation measures and finally determining rough cost estimates for those measures. The Jacksonville District coordinated with other resource agencies and Broward County (the local sponsor) to develop a variety of mitigation alternatives to address the specific impacts associated with the project.

From a broad perspective, mitigation planning consisted of the following three major steps:
1) avoiding impacts to the maximum extent practicable,
2) reducing impacts to the maximum extent practicable, and
3) providing habitat replacement/compensation.

Mitigation (or replacement/ compensation) can include restoration, enhancement, establishment, or preservation. Whichever option is selected, it should offset impacts, it should be practicable, and it should be environmentally preferable. The hierarchy for preference of mitigation alternatives from the Mitigation Rule (33 CFR 332) is as follows:

1. Mitigation bank credits
2. In-lieu fee program credits
3. Permittee-responsible mitigation under a watershed approach
4. On-site and/or in-kind permittee-responsible mitigation
5. Off-site and/or out-of-kind permittee-responsible mitigation

Although USACE intends to avoid adverse impacts to the environment, rarely can a major construction project be implemented without causing some adverse effects. The type, location, and level of these impacts must be known before actions can be evaluated to avoid those impacts, reduce those impacts or provide appropriate mitigation. Most impacts that could be expected to occur from this proposed project would result from loss of hardbottom habitats offshore, loss of wetlands adjacent to the (expanded) navigation channel or turning basins, or loss if seagrass habitat within Port Everglades harbor. Other potential impacts could also result, such as changes in shoreline erosion rates in certain areas, salinity intrusion into groundwater, or changes in air emissions.

This report summarizes estimates of project impacts and the feasibility/effectiveness of measures to mitigate those impacts. All mitigation measure cost estimates are generalized and are intended to be used for preliminary planning and coarse cost comparisons only. Costs will be more precisely estimated during the preconstruction, engineering, and design (PED) phase of the project.

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1.0 PROJECT OVERVIEW

The Port Everglades (Port) is a major seaport located on the southeast coast of Florida (Figure 1). The Port has immediate access to the Atlantic Ocean, and is located within parts of the cities of Hollywood, Dania Beach, and Fort Lauderdale (all in Broward County). To the east of the Port is a barrier island that contains a U.S. Navy (USN) facility, a Nova Southeastern University (NSU) facility, a U.S. Coast Guard (USCG) facility, and John U. Lloyd Beach State Park (JUL) and its adjacent beaches. South of the Port's Dania Cutoff Canal (DCC) is the West Lake Park (WLP) area. West of the Port is Federal Highway (U.S. 1) which is flanked by the Fort Lauderdale International Airport (FTL). North of the Port is a mixture of small-craft waterways (Intracoastal Waterway and canals) and commercial and residential development.

The existing federal channel depth of 42 feet at Port Everglades does not provide an adequate, safe depth for large tankers and container ships currently calling at the Port. Those ships must light-load or wait on tides to enter the harbor resulting in transportation inefficiencies and additional expenses. Additionally, the next generation of container ships requires significantly more channel depth to operate efficiently and safely. Specifically, the next generation of container ships comprises post-Panamax vessels, such as the *MV Susan Maersk* with an overall length of 1,138 feet, an extreme breadth of 141 feet, and a maximum draft of 47.6 feet. In contrast, the current largest Panamax container ships have overall lengths of 965 feet, an extreme breadth of 106 feet, and a maximum draft of 44.3 feet.

Economic analyses have shown that improvements to most of the channels and basins serving the Port are required to achieve efficient transit of the existing fleet and to accommodate the future fleet. Avoiding light-loading of ships, allowing for port calls at all tides, and promoting a fewer number of calls with larger vessels (rather than more calls with smaller vessels) will improve the efficiency of port operations and mitigate the costs of products brought in through the Port.

The Port Everglades pilots have expressed significant concem regarding the safety of navigation to and within the existing federal channels. The entrance channel has dangerously strong cross currents which vary in strength and are unpredictable in direction. These currents generally run at right angles to the direction of the narrow entrance channel making transit hazardous, without local knowledge, for deep draft vessels. These currents have been reported to be as much as 5 knots (National Ocean Service 2010). A wider and deeper entrance channel and deeper inner entrance channel will greatly improve the safety of navigation.

The primary objectives of the federal project are to provide for existing and future vessel movements, resolve navigation restriction problems (including those related to navigation safety), and present opportunities for national economic development.


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Broward Co., FLc
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Milesc
Study Area
Port Everglades
Navigation Improvements Mitigation Plan
Scale: 1" ,0
Drawn By: Mc
Date: March 2011
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC
J11-1182
Figure 1c

2.0 HABITAT IMPACTS DUE TO PROJECT CONSTRUCTION

The existing authorized Port Everglades Federal Navigation Project comprises an Outer Entrance Channel (OEC), an Inner Entrance Channel (IEC), a Main Turning Basin (MTB), a North Turning Basin (NTB), a South Turning Basin (STB), a Southport Access Channel (SAC), and a Turning Notch (TN). The deepening and widening of various components (see main text of the Environmental Impact Statement (EIS) for details and maps) will achieve project objectives. The locally preferred plan (LPP), which is also the Government's Recommended Plan, consists of the following navigation improvements (see the EIS for figures):

a increase the authorized depth of the OEC from 45 feet (actual existing depths vary) to 48 feet (-48 feet MLLW) (i.e., an *actual* depth of up to 57 feet due to engineering and safety requirements), widen the seaward end of it from 500 feet to 800 feet, and extend the channel 2,200 feet seaward;

b. increase the authorized depth of the IEC from 42 feet to 48 feet (resulting in an actual depth of 50 feet);

c. increase the authorized depth of the MTB from 42 feet to 48 feet (resulting in an actual depth of 50 feet);

d. widen the rectangular shoal region (the Widener, or "WID") by approximately 300 feet to the southeast of the MTB and deepen it to a new authorized depth of 48 feet (resulting in an actual depth of 50 feet);

e. widen the SAC in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 feet and relocate the United State Coast Guard (USCG) facility, a General Navigation Feature (GNF), easterly on USCG property;

f. shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition back from the expanded Widener area in the north to the existing federal channel limits to the south;

g. increase the authorized depth of the SAC from 42 feet to 48 feet (from the area adjacent to berth 23 to the south end of berth 32), resulting in an actual depth of 50 feet;

h. deepen the TN, including an area currently being expanded and incorporated into the TN by the local sponsor, from 42 feet to 48 feet (resulting in an actual depth of 50 feet); widen the SAC to the east (across from the TN) by an additional 100 feet over a length of about 1,845 feet; and widen the western edge of the SAC from near the south end of berth 29 to a width of up to approximately 130 feet at the north edge of the TN;

i. conduct environmental mitigation (see below);

j. pre-treat rock substrates as necessary and take appropriate measures to safeguard protected species during that process;

k. dispose of dredged material east of the Port at the Ocean Dredged Material Disposal Site (ODMDS), which is currently proposed for expansion by US Environmental Protection Agency (USEPA). If it is not expanded, the maximum amount of material that can be placed within the existing site will be deposited, and alternatives will be explored for the deposition of remaining material (NEPA coordination to that effect are currently underway).

The Port's 20-year Master/Vision Plan agreement with the Florida Department of Environmental Protection (FDEP) includes expansion of the TN to increase berth capacity. This 400-foot expansion includes the release from the existing 48.27-acre conservation easement of approximately 8.68 acres west of the TN, and deepening the entire notch to 42 feet MLLW. The notch expansion is considered a future without-project condition and is the sole responsibility of the sponsor (Broward County).

To achieve the above expansion and reconfiguration in accordance with the Recommended Plan (i.e., the LPP), several resource types will be impacted. These are listed below in Table 1. The existing condition and value of the impacted resources, and anticipated future-without-project condition of these resources, are discussed in detail in the Environmental Impact Statement (Sections 3.5.2, 3.6.1, and 3.6.2; and Sections 4.3.1, 4.4.1.1, and 4.4.2.1, respectively).

USACE guidance on mitigation states that mitigation will be conducted for "significant" ecological resources compared to the future-without project condition. The habitat types noted in Table 1 classified as "Resources for which mitigation is proposed" are jurisdictional mangrove wetlands, seagrass beds, and hardbottom/reef habitats that have not been previously dredged. For areas within the Recommended Plan's footprint that were previously dredged and which will return to their current state in a relatively short time period, such as silt/sand bottom, and channel walls, mitigation will not be provided (USACE *ER 1105-2-100, Appendix C (Environmental Evaluation and Compliance) Appendix C (Paragraph C-3.d (4)(b)).*

To compensate for unavoidable impacts to these habitat types, USACE has proposed a mitigation plan that will restore the ecosystem functions lost due to removal of wetland, seagrass, and hardbottom habitats in areas that were not previously dredged. The functional value of each of these is briefly discussed below. Additional details are provided in the Environmental Impact Statement.

Mangroves. Mangroves are the dominant wetland type within the study area. Mangroves also represent the largest natural habitat within the project boundaries, and are found in both natural and created wetlands. These habitats comprise either stands of red mangrove (*Rhizophora mangle*) or mixed stands of red mangrove and black mangrove (*Avicennia germinans*). Major associates include white mangrove (*Languncularia racemosa*) and buttonwood (*Conocarpus erectus*). Mangroves are important for shoreline protection and stabilization. In addition, mangrove habitats provide many important ecological functions, including providing refugia for juvenile stages of managed fish species, and have been identified as significant resources for seven federally protected species, and four federally protected subspecies (Odum and McIvor 1990). These systems also provide organic matter that forms the basis of a littoral-zone, marine food web. Sloughs (channels of slow-moving water) penetrate mangrove wetlands adjacent to channel areas. Some of these sloughs are natural, while some are man-made. These are extremely important areas that provide species with passageways for movement into and out of interior mangrove areas. They are also important for refuge and feeding areas for various fishes and invertebrates. These habitats are important within Broward County since the County is urbanized and most of the previously existing mangrove habitat has been removed.

The largest (by area) mangrove habitats in the project area occur along the western shore of JUL and north and west of the TN. Some fringing mangrove wetlands in JUL comprise habitat created by the Port as mitigation for previous impacts to native areas of mangrove. Sloughs, both manmade and natural, are associated with both of these major mangrove areas.

Table 1 Approximate Acreages of Direct Impacts of the Port Everglades Harbor Navigation Study Recommended Plan by Construction Element and Habitat Type

	Habitat Type	Turning Notch	Southport Access Channel	Widener	Main Turning Basin	Inner Entrance Channel	Outer Entrance Channel	Subtotal per Habitat Type**
Resources for which **NO** mitigation is proposed	Uplands: forest and scrub-shrub		0.37					0.37
	Previously dredged Inlet channel					26.76	56.61	83.37
	Unconsolidated substrates: soft bottom	26.03	119.28	10.94	120.48	4.12		280.85
	Unconsolidated substrates: sand					3.39	9.95	13.34
Resources for which mitigation **IS** proposed	Seagrasses: non-special-status		0.15	0.21	*	0.08	0.20	0.64
	Seagrasses: *Halophila johnsonii* only (special-status)		1.77	1.39				3.16
	Seagrasses: *H. johnsonii* with other species		0.18	0.23				0.41
	Wetlands: mangroves		1.16					1.16
	Hardbottom: shallow colonized pavement						0.02	0.02
	Hardbottom: deep colonized pavement						4.73	4.73
	Linear reef: middle tract						4.92	4.92
	Linear reef: outer tract						4.14	4.14
	Spur and groove reef: outer tract						0.73	0.73
	Unclassified hardbottom						0.09	0.09
	Subtotals	26.03	122.91	12.77	120.48	34.15	80.66	397.93

*Approximately 87 square feet for the sum of two areas. **Impacts do not include channel wall impacts, incidental impacts due to dredge equipment, below-dredge-depth incidental impacts, or indirect impacts to hardbottoms due to water quality. Source: DC&A September 2014 ArcInfo GIS analysis using 2008 LADS for offshore bathymetry.

Seagrasses. The Port project area supports sub-tropical and tropical seagrass communities including *Halophila decipiens* (paddle grass), *Halodule wrightii* (shoal grass), *H. johnsonii* (Johnson's seagrass), and associated green calcareous and brown algae, such as *Penicillus* spp., *Halimeda* spp. and *Caulerpa* spp. Seagrasses colonize soft sediments, generally at the edge of the channel, starting in the IEC, going south to beyond the DCC. These seagrass beds are valuable to fish, manatees, and invertebrates which use them as nursery and foraging grounds within Broward County. Since most of the marine inland waters within Broward County are artificially constructed and channelized, suitable habitat for seagrass beds is limited within Broward County.

Hardbottom and Coral Reef. The reef complex within the project area is comprised of a nearshore ridge complex, and a seaward succession of three shore-parallel reefs referred to as the "inner," "middle, and "outer" reefs, or the "first," "second", and "third" reefs, respectively (Goldberg 1973; Moyer *et al.* 2003; Banks *et al.* 2007). The nearshore ridge complex runs parallel to the shore and is made up of carbonate/quartz sandstone and coquina rock (Banks *et al.* 2007). The nearshore ridge complex occurs in 0-12 feet (0-4 m) of water and hosts a hardbottom community of algae, sponges, encrusting octocorals, and hard corals (CSA 2009). These hardbottom communities exist in a dynamic environment, and may be periodically covered and uncovered by sands as a result of storms and/or littoral transport. Seaward of the nearshore ridge complex, the inner reef occurs from approximately 100 to 2,000 feet (30 to 610 m) from shore and crests at 26 feet below MHW (8 m); the middle reef is located 3,000 to 6,000 feet (914 to 1,829 m) from shore in 49 feet (15 m) of water (MHW); and the outer reef is approximately 8,000 feet (2,438 m) or more offshore and crests at 52 feet below MHW (16 m) (USACE 1996; Banks *et al.* 2007). The troughs between the inner and middle, and middle and outer reefs are characterized by sand and coral rubble with isolated patches of hardbottom and hard corals (USACE 1996).

Hardbottom and coral reefs in the project area are dominated by fauna typical of the wider-Caribbean basin (Goldberg 1973). These include in order of abundance, octocorals, sponges, and hard corals (DC&A 2009; Moyer *et al.* 2003; Goldberg 1973). These reefs have been characterized as octocoral dominated reefs (Moyer *et al.* 2003; Goldberg 1973). Goldberg (1973) described the rich diversity of octocoral species characteristic of this reef system. Thirty-nine species of octocorals were found to be represented including *Eunicea*, *Plexaura*, and *Pseudopterogorgia,* and 27 species of scleractinian corals have been documented (Goldberg 1973). The predominant hard coral genera in S. Florida include *Siderastrea*, *Montastraea*, *Stephanocoenia,* and *Porites* (DC&A 2009). Recently, 45 hard coral species were documented in Broward County by Banks *et al.* (2009), while, Moyer *et al.* (2003) found 30 across the county. Nineteen hard coral species were found on the middle and outer reefs within and adjacent to the project area in 2006 (DC&A 2009). Typical sub-tropical sponges are found along the reefs, including, but not limited to members of *Ircina, Agelas, Iotrochota, Verongula*, and *Xestospongia* genera (DC&A 2009). Associated sub-tropical fish species use the reef for foraging, shelter, and breeding habitat.

3.0 MITIGATION PLANNING AND POLICIES

Compensatory mitigation is intended to replace the ecological services that are lost as a result of unavoidable impacts to resources affected by a given project. "Ecological services" refer to the services performed by a resource for the benefit of other resources or the public. The baseline for quantifying lost ecological services is the full complement of services that would have been provided absent project implementation. Lost ecological services are quantified as the reduction in the provision of services below this baseline. Compensatory mitigation must restore services commensurate with the character of lost services. The amount of compensatory mitigation needed to replace lost services depends, in part, on the ability of the affected resources to retum to their baseline conditions. Factors relevant in that regard include the quantity of affected resources and how fast and how completely they return to their baseline conditions. The amount of compensatory mitigation also depends on the ability of the selected compensatory mitigation measures to replace lost services. Relevant factors for replacement include how fast the compensatory mitigation measures become fully functional and the relative degree to which they provide additional ecological services (King 1997).

USACE mitigation policies are stated in Section 2036(a) of the Water Resources Development Act (WRDA) of 2007 and implementation Guidance for Section 2030 of WRDA 2007 dated August 31, 2009. The *Memorandum for Commanders, Major Subordinate Commands* regarding *Implementation Guidance for Section 2036(a) of the Water Resources Development Act of 2007- Mitigation for Fish and Wildlife and Wetlands Losses* (31 August 2009) emphasized that "ER 1105-2-100 requires that mitigation planning be an integral part of the overall planning process," in accordance with the USACE/EPA rule issued on March 31, 2008 discussed above. Section 2036(a) of the 2007 Water Resources Development Act (WRDA '07) amends Section 906(d) of the WRDA of 1986 to:

- Ensure that any report submitted to Congress for authorization has specific recommendations for mitigating fish and wildlife losses;
- Ensure that other habitat types [i.e., non-wetland] impacted by a project are mitigated to not-less-than in-kind condition, to the extent practicable;
- Require that mitigation plans include (1) "monitoring-until-successful" language; (2) criteria for determining ecological success; (3) a description of available lands for mitigation and the basis for the determination of availability of said lands; (4) development of contingency (adaptive management) plans; (5) identification of parties responsible for monitoring; and (6) establishment of a consultation process with appropriate federal and state agencies in determining the success of mitigation.

Furthermore, USACE requires plans to include information regarding the minimum monitoring actions necessary to evaluate success, including key project-specific parameters.

The USACE *Memorandum for Commanders, Major Subordinate Commands* regarding *Implementation Guidance for Water Resources Development Act of 2007-- Section 2036(c) Wetlands Mitigation* (6 November 2008) noted the importance of use of a mitigation bank to compensate for wetland impacts that occur within the service area of an existing, approved bank. Regarding the proposed project, there are no existing mitigation banks in the watershed to address impacts to mangrove wetlands, seagrass beds or coral and hardbottom communities (www.usace.army.mil/Portals/2/docs/civilworks/Project%20Planning/wrda/2007/sec_2036c.pdf).

USACE will provide compensatory mitigation for functional losses of significant habitats, these being jurisdictional wetlands, seagrass beds, and hardbottom/reef habitats that are outside of the existing (and maintained) channel limits. The significance of the affected resources in the study area is based on the technical, institutional and public recognition of the ecological, cultural, and aesthetic attributes of the subject resources. Resource scarcity and/or uniqueness (from a national, regional, state, and local perspective) are important considerations in determining significance (Paragraph C-3.d (4)(a) of Appendix C, "Environmental Evaluation and Compliance" of ER 1105-2-100.

WRDA 2007 required USACE to be consistent with regulatory rules 33 CFR 332.3 (regarding type and location of compensatory mitigation) which states the following:

> "the required compensatory mitigation should be located within the same watershed as the impact site, and should be located where it is most likely to successfully replace lost functions and services, taking into account such watershed scale features as aquatic habitat diversity, habitat connectivity, relationships to hydrologic sources (including the availability of water rights), trends in land use, ecological benefits, and compatibility with adjacent land uses. When compensating for impacts to marine resources, the location of the compensatory mitigation site should be chosen to replace lost functions and services within the same marine ecological system (e.g., reef complex, littoral drift cell). Compensation for impacts to aquatic resources in coastal watersheds (watersheds that include a tidal water body) should also be located in a coastal watershed where practicable. Compensatory mitigation projects should not be located where they will increase risks to aviation by attracting wildlife to areas where aircraft-wildlife strikes may occur (e.g., near airports)."

The proposed mitigation for unavoidable impacts due to improvements at Port Everglades meets all of these requirements.

4.0 MITIGATION FOR UNAVOIDABLE IMPACTS TO SEAGRASS HABITATS

4.1 Determining Mitigation Needs for Seagrasses

Seagrass mitigation requirements were determined using the State of Florida's Uniform Mitigation Assessment Method (UMAM) assessment (worksheets are available in Appendix E-1). UMAM is a method used to determine mitigation needs based upon a number of quantitative and qualitative factors. UMAM has been used in other USACE-SAJ projects to help determine mitigation requirements, and its application in this project has been approved for "single-use" for this project by the USACE National Ecosystem Planning Center of Expertise (el.erdc.usace.army.mil/ecocx).

Due to the implementation of the Recommended Plan (i.e., the LPP), a total of 7.41 acres of seagrass habitat (occupied and unoccupied) falls in the project footprint. Of that, a total of 4.21 acres that comprises occupied seagrass habitat will require mitigation (see impact polygons in Appendix E-1). A pre-construction seagrass survey will be conducted prior to construction to determine the final acreage of occupied seagrass habitat that will be impacted and will require mitigation. UMAM calculations indicated that compensation of approximately 2.5 seagrass functional units will offset that impact (Table 2) for the occupied habitat. All credible scientific information regarding the functional value of ephemeral seagrass habitat will be considered at the time of construction to determine the amount of additional mitigation, if any, that should be provided. However, because mitigation construction has already been initiated by the local sponsor under the regulatory permit, revised UMAM calculations during the upcoming Preconstruction Engineering and Design (PED) phase of the project will likely indicate that fewer functional units will be required. This potential decrease is due to the time lag and risk factors in UMAM will be reduced or nearly eliminated by the time impacts occur; construction will have been completed or nearly so by the time impacts occur and mitigation actions will have been producing benefits already. Additionally, Broward County is submitting a permit modification to slightly increase the amount of area to be used for seagrass creation as a contingency in the case that at the time of construction, there are additional sea grasses above the already mapped 4.21 acres of occupied habitat. This modification will increase the available credits from 2.4 to 2.9 in West Lake Park. For cost purposes, the latter number is used in calculations below.

4.2 Seagrass Mitigation Alternatives

Broward County has very limited options for seagrass mitigation. Most of the saline/estuarine water bodies in Broward County are man-made canals used for navigation or flood water management where specific depths must be maintained and filling for mitigation would not be a viable option.

To locate seagrass mitigation options, USACE queried the Broward County Parks Department during their development of the West Lake Park Restoration Project (Figure 2). The Parks Department originally planned to create open mud flats (by removing exotic species) for birds to utilize along the east side of the park bounded by the IWW. After discussions with USACE and the Port, some of the mud flat areas were modified by removing more substrate and allowing natural recruitment of seagrasses into the area from adjacent seagrass beds (Figure 3). The details of this mitigation option (WLP project) are described below in Section 4.4.

In addition to the West Lake Park Restoration project, the USACE looked at two other seagrass mitigation options: 1) filling previously dredged holes in Biscayne Bay, Miami-Dade County (19-25 miles south depending on location of dredge hole) or Lake Worth Lagoon (42 miles north) in Palm Beach County or 2) filling prop scars in the same water bodies. While the sites are in the same watershed as the project area ("Southeast Coastal"), the distance from the impact sites to the alternative mitigation sites is fairly excessive and would result in a net loss of seagrass habitats available to the fisheries and protected species that utilize seagrass and mangrove habitats in/near the project area. The Miami-Dade mitigation site is in Biscayne Bay, which is dominated by climax seagrass species, turtle grass and manatee grass, neither of which has been located in the Port Everglades project footprint, while the seagrasses in the project area are pioneer species, mainly Johnson's seagrass and paddle grass (*Halophila sp.*). There has been some success with filling old dredge holes for mitigation/restoration in both Miami-Dade and Palm Beach Counties: Snook Islands Restoration Project (http://www.pbcgov.com/erm/lakes/estuarine/snook/) and the Miami-Dade County dredge-hole demonstration project (Milano and Deis 2006). Dredge-hole filling projects are good for large scale mitigation needs, and would require transporting dredged material from Port Everglades to Biscayne Bay or Lake Worth Lagoon and identifying a dredged hole that could have the material placed in it with sufficient access for shallow water bottom dump barges. This would result in a significant increase in costs associated with seagrass mitigation when compared to utilizing the West Lake Park restoration project, which is less than one mile to the south of the project. Additionally no dredged material transport would be required as part of mitigation construction at West Lake Park. An analysis of the associated costs is included in the Incremental Cost Analysis below.

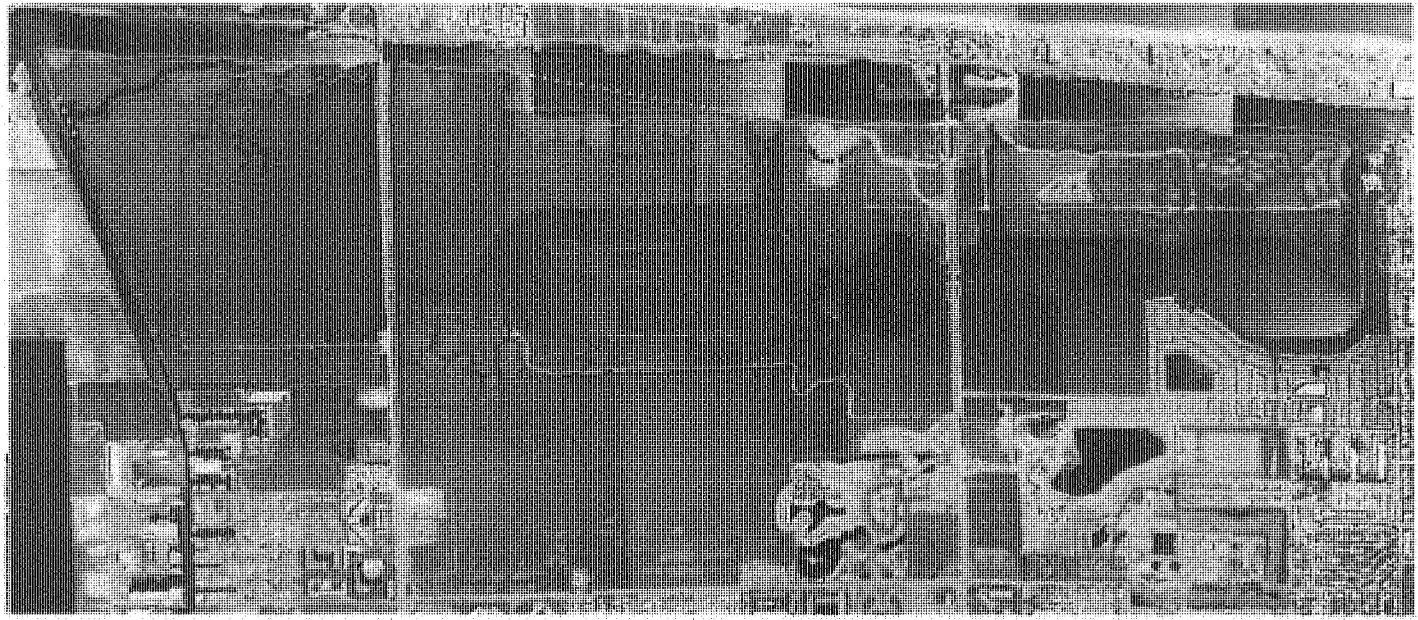
Table 2 Uniform Mitigation Assessment Methodology Scores for Occupied Seagrass Habitats within Impact Area

Impact Polygon*	LS Before**	LS After**	WE Before	WE After	CS Before	CS After	Impact (acres)	Functional Loss (units)
SHD-00818	6	0	6	0	3	0	0.0188	0.0094
SHD-05641	6	0	6	0	3	0	0.1295	0.0647
SHJ-77084	6	0	6	0	10	0	1.7696	1.2920
SMX-01202	6	0	6	0	4	0	0.0276	0.0160
SMX-00515	6	0	6	0	4	0	0.0118	0.0050
SMX-02944	6	0	6	0	4	0	0.0676	0.0370
SMX-00900	6	0	6	0	4	0	0.0207	0.0110
SMX-02192	6	0	6	0	10	0	0.0503	0.0369
WHD-08612	6	0	6	0	2	0	0.1977	0.0940
WHD-00416	6	0	6	0	1	0	0.0096	0.0041
WHJ-53469	6	0	6	0	3	0	1.2275	0.6150
WHJ-06911	6	0	6	0	4	0	0.1587	0.0846
WHJ-10206	6	0	6	0	4	0	0.2343	0.1220
MHD-00037	6	0	6	0	1	0	0.0008	0.0004
MHD-00039	6	0	6	0	1	0	0.0009	0.0004
IHD-03618	6	0	6	0	2	0	0.0831	0.0388
OHD-08712	8	6	8	6	6	0	0.2000	0.0660
						Total	4.2084	2.4973

Key: Fist letter of polygon corresponds to position (S: SAC; W: Widener; M: MTB; I: IEC; and O: OEC), second and third refer to vegetation assemblage (HD: H. decipiens; HJ: H. johnsonii; MX: mixed with H. johnsonii); numbers in polygon refer to size in square feet of SAV bed; LS: Landscape Support; WE: Water Environment; CS: Community Structure.

*Positions of polygons are shown in figures in Section 4.3 and 4.4.1 of the main text of the Environmental Impact Statement.

**"Before"/"After" is relative to impact.



AERIAL PHOTOGRAPH DATE: 2000

DRAFT: Conceptual Plan set. Not for Construction.

NOTE: All channels are 50' unless otherwise noted.

LEGEND

GRAPHIC SCALE

BROWARD COUNTY

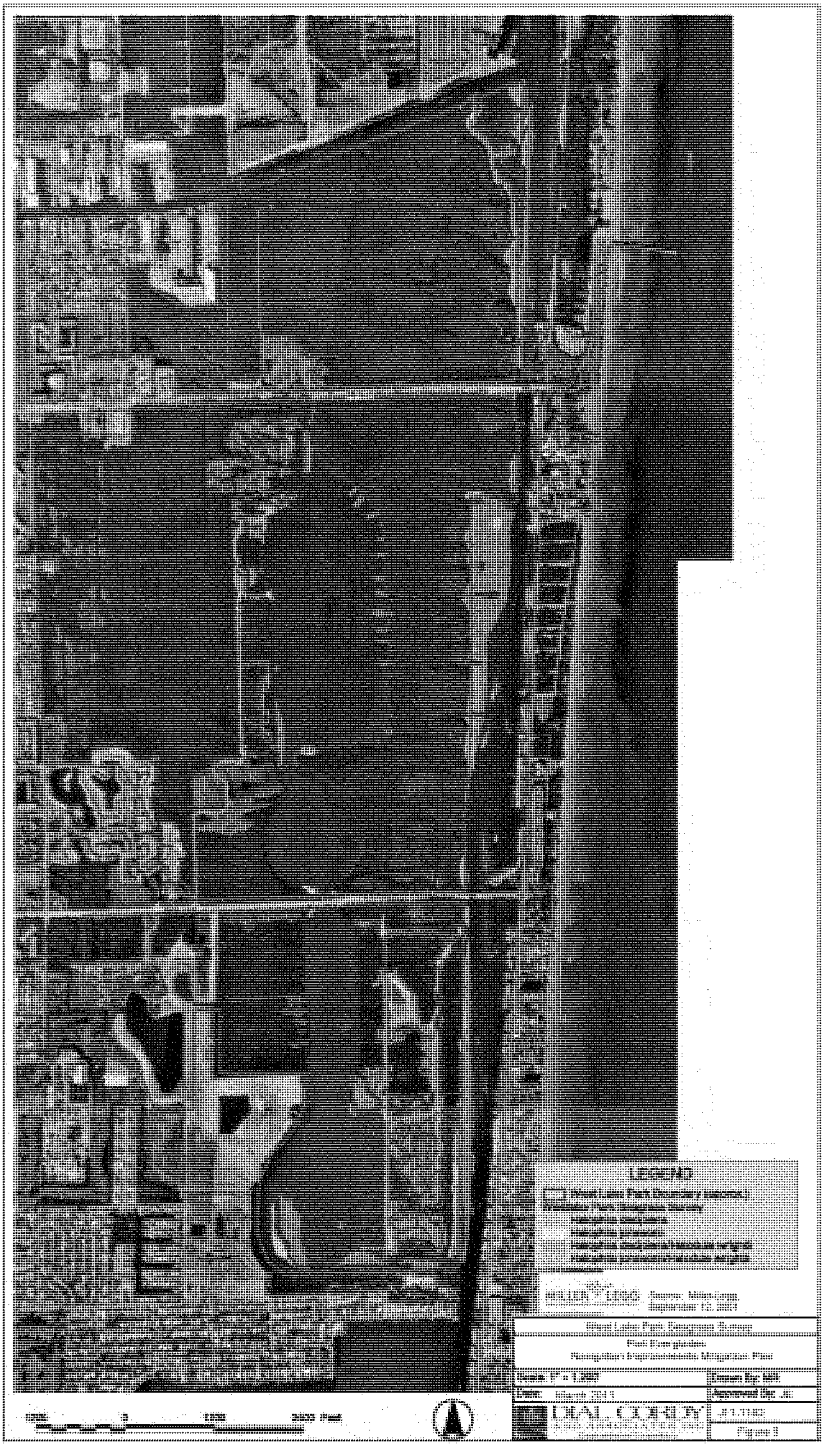
BROWARD COUNTY PARKS AND RECREATION DIVISION

West Lake Park

PROPOSED IMPROVEMENTS

MILLER LEGG

West Lake Park Mitigation Measures Port Everglades Navigation Improvements Mitigation Plan	
	Drawn by: MR
Date: March 2011	Approved By JE
DIAL CORDY	J11-1182
	Figure 2


LEGEND
DIAL CORDY

4.3 Incremental Cost Analysis Results for Seagrasses Mitigation Alternatives

4.3.1 Expected Cost of Altemative Seagrass Mitigation Plans

As noted below, due to the subject mitigation lands at WLP being owned by the State of Florida and leased/managed by the local sponsor (outside of the requirements for the civil works project), no fee-simple transaction is warranted, and the value of the right-of-entry is essentially $0.00. WLP construction as well as monitoring (as required by environmental permits granted by the State of Florida and USACE Regulatory Division) and any adaptive management of WLP restoration elements are being paid for by Broward County. Those costs are estimated at $9,596,466 for elements related to seagrass restoration/creation. Therefore, for the implementation of the WLP alternative for seagrass mitigation, the estimated maximum potential cost for the elements discussed in the plan (see below) is $9,596,466, given that no real estate costs were involved.

The estimated maximum potential cost for the elements necessary to implement the Miami-Dade County alternative was calculated to be $700,000 per acre of seagrass creation/restoration. UMAM calculations indicate that, to offset up to 2.9 seagrass functional units that may be lost due to unavoidable impacts of the Recommended Plan (i.e., the LPP) (currently, losses of only 2.5 units are projected), approximately 18.47 acres of seagrass creation/restoration will be required. Therefore the initial, expected cost for this mitigation altemative is $12,929,000.

The estimated maximum potential cost for the elements necessary to implement the Palm Beach County alternative was calculated to be $1,000,000 per acre of seagrass creation/restoration. UMAM calculations indicate that, to offset up to 2.9 seagrass functional units that may be lost due to unavoidable impacts of the Recommended Plan (currently, losses of only 2.5 units are projected), approximately 18.47 acres of seagrass creation/restoration will be required. Therefore the initial, expected cost for this mitigation alternative is $18,470,000.

4.3.2 Seagrass Mitigation Benefits

Approximately 2.4 to 2.9 seagrass functional units will be created (the latter due to permit modification) by the actions discussed in Section 4.4. It is estimated that approximately 2.5 functional units for seagrasses will be used to compensate for seagrass impacts resulting from improvements at Port Everglades. For the discussion below, *functional units* will be the basis for determining benefits, and as noted above.

4.3.3 Construction/ Initial Cost per Seagrass Functional Unit

The base-year cost of each alternative mitigation plan is compared to the respective benefit (functional unit) below (see Table 3). Costs are based on FY2014 estimates (annualized values are provided in the Economic Appendix of the Feasibility Study) based on data provided by Broward County's previous experience with construction at WLP. However, cost will likely be less as fewer functional units are likely to be necessary for use (due to a decreased time lag factor and risk) as discussed in Section 4.1.

Table 3 Construction/ Initial Cost per Functional Unit of Seagrass Mitigation

Seagrass Mitigation Alternative	Construction Cost of Mitigation	Benefits of Mitigation (functional units)	Cost/Functional Unit
WLP Seagrass Enhancements	$9,596,466	1.0	$3,864,876
Miami-Dade Seagrass Enhancements	$12,929,000	1.0	$5,298,770
Palm Beach Seagrass Enhancements	$18,470,000	1.0	$7,569,672

4.3.4 Cost-Effective Seagrass Mitigation Plan

Cost estimates for the above three mitigation alternatives (West Lake Park, Miami-Dade County site, and Palm Beach County site) were calculated (as shown above), and those costs were used in an incremental cost analysis. It was determined through use of USACE Institute of Water Resources (IWR) software (IWR Planning Suite 1.0.11.0, certified 24 September 2008) that the West Lake Park habitat restoration alternative was the "Best Buy" alternative and that the other three altematives were "Non Cost-Effective." Given that finding, the WLP alternative described above was selected as the proposed mitigation plan for impacts to seagrasses due to the implementation of the Recommended Plan.

4.4 Proposed Mitigation Plan for Seagrasses

Unavoidable impacts to seagrasses will be mitigated by using credits (functional units) generated by habitat improvements at West Lake Park. The park land is owned by the State of Florida and leased by Broward County Parks and Recreation Division (BCPRD) on lands purchased under the CARL program. Liability for construction, monitoring, and success for mitigation at West Lake Park rests solely with Broward County (the local sponsor). No real estate will be purchased by the USACE or the local sponsor. Access to the identified lands to perform the subject construction would be allowed via a right-of-entry for construction (minimum real estate interest sufficient to perform subject construction). The right-of-entry for construction is currently afforded to the local sponsor via an existing lease agreement executed in 1986 for a period of 50 years. Again, fee simple is not required, as the mitigation plan for this project consist only of the construction features as agreed to between the local sponsor and the State of Florida and USACE Regulatory Division. The mitigation plan does not have any monitoring or operation/management features. Due to the property being owned by the State of Florida and currently managed by the local sponsor (outside of the requirements for the civil works project), the value of the right-of-entry is essentially $0.00.

The West Lake Master Plan (Miller-Legg 2003) was developed by BCPRD in consultation with Broward County's Port Everglades Department and the Broward County Aviation Department. The functional gains generated by the improvements have been approved (pursuant to county, state, and federal permits) to offset impacts due to projects constructed by various Broward County departments (among which are the Port and the Aviation Department, including Fort Lauderdale-Hollywood Intemational Airport). Permits for WLP habitat improvements (see Appendix E-2) were issued by the South Florida Water Management District in April 2004, by the Broward County Environmental Protection Department in August 2004, and the USACE-SAJ Regulatory Division in March 2006. The WLP project was not permitted as a "mitigation bank." Therefore, there are no "credits" available for purchase by other public or private entities to offset impacts from other projects.

The ecological value of improvements, which will be gained through the WLP project, was assigned via use of State of Florida's UMAM, as is standard practice for Clean Water Act (CWA) Section 404 and Section 401 permitting in the state. As proposed, the WLP plan involves creation of 8.0 acres of seagrass, restoration of 0.5 acre of seagrass habitat, and protection of 30.0 acres of seagrass/manatee habitat. Other measures included in the plan are creation of 7.0 acres of shallow water tidal flats and 8.6 acres of channels, and hydrologic improvements affecting an additional 3.5 acres (Table 4). Specific construction and operational information are detailed in the Department of Army permit, found in Appendix E-2. These activities will result in the accumulation of approximately three wetland functional units, in accordance with permit conditions, for use as mitigation for only Broward County projects.

Table 4 Habitat Restoration and Enhancement Elements at West Lake Park

Element	Acres
Mangrove wetland creation	24.2
Mangrove wetland enhancement	40.4
Mangrove wetland preservation	23.3
Herbaceous saltwater habitat enhancement	10.0
Shallow water tidal flat creation	7.0
Channel creation	8.6
Seagrass creation	8.0
Seagrass restoration (removal of barges)	0.5
Hydrologic improvements*	3.5
Seagrass/Manatee protection	30.0

*Circulation/flushing/dredging improvements are estimated to restore 40-60 acres of SAV in West Lake embayment. Adapted from Miller-Legg (2002)

As noted above in Section 4.1, based on UMAM calculations, mitigation for the proposed project require up to approximately 2.5 wetland functional units to compensate for the up to 5.13 acres of impacts to seagrass beds due to the implementation of the Recommended Plan. Therefore, 2.5 units will be removed from the up-to-three (3) units generated by the WLP project.

"Seagrass creation" areas (the 8.0 acres listed in Table 4) will be developed through the grading of spoil islands along the IWW (to an elevation consistent with the depths where seagrass beds are present adjacent along the IWW, likely between from -1 foot to -4 feet MSL), as denoted by the yellow-stippled areas on Figure 2. Installation of floating barriers to restrict vessel access will help ensure success. It is anticipated that seagrass recruitment will occur rapidly by shoal grass (*Halodule wrightii*), paddle grass (*Halophila decipiens*), and Johnson's seagrass (*Halophila johnsonii*), all of which commonly occur along the shallow flats adjacent to the mangrove fringe. In the event that natural recruitment has not occurred within 12 to 18 months following excavation, methods to plant seagrass donor material will be initiated. Planting methods will follow guidance by Fonseca, et al. (1998).

Submerged aquatic vegetation (SAV) restoration within WLP is also anticipated to occur as a result of enhanced flushing and circulation patterns along the southeastern region of the interior lagoon (Figure 2). As proposed, over 12 acres of flushing channels will be expanded or improved, or will benefit from the installation of culverts, resulting in improved water quality, clarity, and substrate conditions more suitable for seagrass propagation in the interior embayment (Miller Legg 2001b).

Seagrass surveys conducted in West Lake serve to illustrate the benefits of flushing channels, as evidenced by the presence of seagrass beds near the mouth of each channel entering the lake (Miller Legg 2001c) (Figure 3). Based on observed changes in seagrass cover and existing seagrass bed occurrences it is anticipated that 40 to 60 acres of SAV, including *H. johnsonii* would be restored.

4.5 Monitoring and Adaptive Management for Seagrass Mitigation

The West Lake Park plan (as proposed by Broward County and permitted by the State of Florida and USACE Regulatory Division) describes the mitigation monitoring as follows:

> A time-zero monitoring event will be performed, and then the seagrass recruitment area shall be monitored quarterly for the required five-year period. Forty paired, one-square meter quadrats will be randomly placed within the created seagrass habitat during each monitoring event. Distribution of the 40 quadrats will be divided equitably between the seven seagrass creation areas. Random, rather than fixed, quadrats will be used so that the results are without bias and can be used to accurately generalize over the entire area (Fonseca, personal communication). Random directions and distances will be chosen using a random number generator. The random direction and distance will be from the approximate center of each seagrass creation area. An equal number of replicate quadrats will be established in the adjacent, surrounding, seagrass beds (at least 50' from the creation areas) to serve as a control. The following data will be collected at each quadrat:
>
> - Relative water depth
> - Time
> - Species present
> - Shoot counts
> - Aerial coverage by photo-documentation
> - Qualitative observations of natural seagrass recruitment and vegetative expansion of planting units
>
> In addition to the above-listed data, the following data may also be collected for each monitoring event: tides, weather, water temperature, and wind. A staff gauge or piezometer shall be installed to record tide level. Survivorship rates may be assessed based on measurements within the paired 1 m^2 quadrats. Abundance measurements shall be made through visual and photographic assessments of percent aerial coverage by species. The 1-m^2 quadrat shall be divided into 10 cm x 10 cm grid and the number of squares containing seagrasses shall be counted to estimate cover. In addition, percent aerial coverage will be equated to Cover Classes, based on the Braun-Blanquet technique (Table 5). Seagrass success criteria shall be based on the following:
>
> 1. A target goal of Cover Class 1 coverage by the third year
> 2. A target goal of Cover Class 2 or higher by the fifth year
> 3. Supplemental seagrass will be planted on 2-meter centers if...
>
>   a) at the end of the third year, areas have a Cover Class less than 1 or equivalent to coverage in the ICWW (control site), whichever is lower.
>
>   b) at the end of the fifth year, areas have a Cover Class less than 2 or equivalent to coverage in the ICWW (control site), whichever is lower.

Table 5 Braun-Blanquet Cover Class Definitions

Cover Class	Description
0	Shoots absent
0.1	Solitary individual shoots, less than 5% cover
0.5	Few individual shoots, less than 5% cover
1	Many individual shoots, less than 5% cover
2	5% - 25% cover
3	25% - 50% cover
4	50%
5	75%

4.6 Seagrass Mitigation Success Criteria

Seagrass success criteria for the WLP seagrass mitigation beds are as follows:

1. A target goal of Cover Class 1 coverage by the third year or equivalent to the coverage in the ICWW (control site) whichever is lower.

2. A target goal of Cover Class 2 or higher by the fifth year or equivalent to coverage in the ICWW (control site) whichever is lower.

If success criteria are not achieved adaptive management will be used to implement contingency planning.

4.7 Adaptive Management/Contingency Plan for Seagrass Mitigation

The contingency plan for taking corrective action will be implemented if and when the seagrass mitigation does not achieve success described in the paragraph above. Supplemental seagrass will be planted on 2-meter centers if either of these occur (related costs are shown in Table 6):

a) At the end of the third year, areas have a Cover Class less than 1 or equivalent to coverage in the ICWW (control site) whichever is lower.

b) At the end of the fifth year, areas have a Cover Class less than 2 or equivalent to coverage in the ICWW (control site) whichever is lower.

Table 6 Mitigation Costs with Adaptive Management Added

Seagrass Alternative	Construction Cost of Mitigation	Monitoring and Adaptive Management Costs	Total Costs
WLP Seagrass Enhancements	$9,596,488	$114,700	$9,827,866

5.0 MITIGATION FOR UNAVOIDABLE IMPACTS TO MANGROVE WETLANDS

5.1 Determining Mitigation Needs for Mangrove Wetlands

Mangrove mitigation requirements were determined using UMAM (worksheets are available in Appendix E-1). Due to the implementation of the Recommended Plan, 1.16 acres of mangroves will be impacted (mangrove impact polygons also available in Appendix E-1). UMAM calculations indicated that compensation of 0.81 wetland functional unit (see Table 7) will offset that impact (for simplicity, 1.0 unit is used in cost calculations). However, because mitigation construction has already been initiated, revised UMAM calculations during the upcoming Preconstruction Engineering and Design (PED) phase of the project will likely indicate that fewer functional units will be required. This is because the time lag factor and risk factor used in UMAM calculations will be reduced or nearly eliminated by the time impacts occur, decreasing the required number of functional units.

Table 7 Uniform Mitigation Assessment Methodology Scores for Mangrove Habitats Within Proposed Impact Areas

All project impacts are along the Southport Access Channel			Location & landscape support		Water environment		Vegetation structure		Resulting calculated change (functional units)
Impact Polygon	Acres		without impact	with impact	without impact	with impact	without impact	with impact	
SWL-03677	0.084		6	0	7	0	5	0	-0.05
SWL-14789	0.340		6	0	7	0	5	0	-0.20
SWL-05202	0.119		6	0	7	0	5	0	-0.08
SWL-03093	0.071		8	0	8	0	9	0	-0.15
SWL-03918	0.090		8	0	8	0	9	0	-0.19
SWL-09492	0.218		8	0	8	0	9	0	<-0.00
SWL-00144	0.003		6	0	7	0	9	0	-0.01
SWL-09620	0.221		6	0	7	0	9	0	-0.19
SWL-00386*	0.009		8	0	8	0	8	0	<-0.00
Cumulative change in functional value of mangroves in impact area due to project:									0.81

*Based on nearest area evaluated in CSI (2008); not field-verified.
All other data based on interagency meeting, June 2005 at USEPA West Palm Beach office, and subsequent GIS updates of coverage.

5.2 Mangrove Wetland Mitigation Alternatives

There are few locations for constructing mangrove mitigation in Broward County. Mangroves require shallow, quiet saline/estuarine waters to germinate, and as previously stated, most of the saline/estuarine waters in Broward County are man-made canals for navigation or flood water drainage. There are a few county and state parks in Broward County with mangroves, or the ability to support mangrove habitat including John U. Lloyd State Park and West Lake Park. To locate mangrove mitigation options, USACE explored options with the Broward County Parks department. These discussions took place during the planning and development of the West Lake Park Restoration Project. The Park's Department plans included removal of exotics and improvement of water flow regimes to create mangrove habitat. Given the proximity of WLP to the project area, county staff concurred that its use for mitigation was a viable option.

Mangrove mitigation options were also available in county and state parks in Miami-Dade and Palm Beach Counties, and while they are in the same watershed ("Southeast Coastal"), the distances from the impact sites to the alternative sites (approximately 19 miles to north Biscayne Bay or 42 miles to Lake Worth Lagoon) were considered excessive and would result in a net loss of mangrove habitats available to the fisheries and protected species that utilize mangrove habitats in the project area. Therefore these options were removed from consideration. Also, no mitigation banks for mangroves were available near the project area.

5.3 Incremental Cost Analysis Results for Mangrove Wetland Mitigation Alternatives

5.3.1 Expected Cost of Alternative Mangrove Wetland Mitigation Plans

For the implementation of the WLP plan, the estimated maximum potential cost for the elements discussed in the plan (see below) comprises $16,956,840 (including a 33% contingency based on lessons learned by the county during construction of Phase 1 on WLP for impacts associated with the airport) for creation of 7.8 functional units of mangroves. From this component, the feasibility study requires only 0.81 units (for conservative purposes, we will use 1.0 for estimates/calculations) to be allocated. Therefore the cost for the required amount of mitigation is approximately $1,456,549 ($16,956,840 * .33 = $5,595,757. $16,956,840-$5,595,757 = $11,361,083/7.8FG) for one functional unit. As noted below, due to the subject mitigation lands being owned by the State of Florida and leased/managed by the local sponsor (outside of the requirements for the civil works project), no fee-simple transaction is warranted, and the value of the right-of-entry is essentially $0.00.

5.3.2 Mangrove Wetland Mitigation Benefits

Approximately 7.8 mangrove functional units will be created by the actions at WLP detailed below. However, as noted above, based on UMAM calculations, USACE will require use of only up to 1.0 wetland functional unit for the proposed improvements proposed in the Port Everglades feasibility study. For the discussion below, functional units will be the basis for determining benefits.

5.3.3 Construction/ Initial Cost per Mangrove Wetland Functional Unit

The base-year cost of each alternative mitigation plan is compared to the respective benefit (functional unit) below (see Table 8). Costs are based on FY2013 estimates (annualized values are provided in the Economic Appendix of the Feasibility Study). However, cost will likely be less as fewer functional units are likely to be necessary for use (due to decreased time lag and risk factors) as discussed in Section 5.1.

Table 8 Construction/ Initial Cost per Functional Unit of Mangrove Mitigation

Mangrove Mitigation Alternative	Construction Cost of Mitigation	Benefits of Mitigation (functional units)	Cost/Functional Unit
WLP Mangrove Enhancements	$1,416,249	1.0	$1,416,249

5.3.4 Cost-Effective Mangrove Wetland Mitigation Plan

An alternative is considered cost effective if no other alternative provides the same level of output for less cost, and if no other plan provides more output for the same or less cost (ER 1105-2-100). The table above shows the comparison of plans. However, as only one alternative plan is proposed, that plan is the cost-effective mangrove mitigation plan.

5.4 Proposed Mitigation Plan for Mangrove Wetlands

Unavoidable impacts to mangrove wetlands will be mitigated by using credits (functional units) generated by habitat improvements at West Lake Park. Section 4.4 of this document provides an overview of West Lake Park. The park land is owned by the State of Florida and leased by Broward County Parks and Recreation Division (BCPRD). Liability for construction, monitoring and success for mitigation at West Lake Park rests solely with Broward County (the local sponsor). No real estate will be purchased by the USACE or the local sponsor. Access to the identified lands to perform the subject construction would be allowed via a right-of-entry for construction (minimum real estate interest sufficient to perform subject construction). The right-of-entry for construction is currently afforded to the local sponsor via an existing lease agreement executed in 1986 for a period of 50 years. Again, fee simple is not required, as the mitigation plan for this project consist only of the construction features as agreed to between the local sponsor and the State of Florida and USACE Regulatory Division. The mitigation plan "does not" have any monitoring or operation/management features. Due to the property being owned by the State of Florida and currently managed by the local sponsor (outside of the requirements for the civil works project), the value of the right-of-entry is essentially $0.00.

The ecological value of improvements, which will be gained through the WLP project, was assigned via use of State of Florida's Uniform Mitigation Assessment Methodology (UMAM), as is standard practice for Clean Water Act (CWA) Section 404 and Section 401 permitting in the state. As proposed, the WLP plan would include the creation (24.2 acres), enhancement (40.4 acres), and preservation (23.3 acres) of mangrove wetlands, and other improvements to various estuarine resources (Table 4). These activities will result in the accumulation of approximately 38 mangrove wetland functional units, in accordance with permit conditions, for use as mitigation for only Broward County projects.

As noted above in Section 5.1, based on UMAM calculations, mitigation for the proposed project will require up to one (1) of the 38 WLP mangrove functional units to compensate for the 1.16 acres of mangroves that will be impacted due to the implementation of the Recommended Plan.

Principal among the actions for creating mangrove habitat is the grading of existing spoil islands to the appropriate depth (between approximately elevation -0.3 feet, or MLW, and elevation 1.7 feet, or MHW). These new habitats will be located along the Intracoastal Waterway (IWW), as indicated by the green hatching in Figure 2. On the side of the habits bordering the IWW, the substrate and plants (three-gallon size red mangrove, *Rhizophora mangle*, installed on three-foot centers) will be protected by riprap to ensure that vessel wakes do not erode the shoreline. These areas together comprise approximately 19.4 acres, a substantial fraction of the 24.2 acres noted for the "mangrove wetland creation" element listed in Table 4.

5.5 Monitoring and Adaptive Management for Mangrove Wetland Mitigation

The monitoring plan for WLP describes the methods used to monitor mangrove growth and succession:

> "Establish one (1) belt transect within each individual mangrove recruitment area. These transects will be two (2) meters wide and will stretch across the approximate maximum length of each recruitment area. One-square-meter quadrats will be randomly placed along the transects at a minimum density of one (1) quadrat per 10 meters of transect (i.e., 100 meter transect will contain 10 quadrats). Though the quadrats will be randomly placed, they will not be placed within "breaks" (i.e., mud flats, pre-existing mangrove areas) in the mangrove recruitment areas. Percent-aerial-coverage, by naturally recruited species falling within the quadrats, will be visually estimated and recorded.
>
> "Data from these sampling quadrats will then be extrapolated to determine overall percent-coverage within each mangrove recruitment area. Once naturally recruited mangrove trees have obtained sufficient height (±1.5 meters) to be recorded individually, trees falling within the belt transects (base of trunk within the transect) would be flagged and measured for height, spread, and diameter breast height (DBH). These measurements will be at random points along the transect at a frequency of one set of measurements per 10 meters. Measurements of these flagged trees will be repeated during subsequent monitoring events to determine growth rates. Overall health would also be assessed."

5.6 Mangrove Wetland Mitigation Success Criteria

Success criteria for mangroves are those described in the WLP mitigation plan; and is based on aerial percent-coverage of recruited shrubs/trees with the following interim goals:

1. 10% aerial coverage by mangroves by the first year.
2. 40% aerial coverage by mangroves by the third year.
3. 80% aerial coverage by mangroves by the fifth year.

5.7 Adaptive Management/Contingency Plan for Mangrove Wetland Mitigation

If the interim success criteria above are not achieved, supplemental mangrove planting will be performed at the cost noted in Table 9. Red mangrove seedlings will be installed on three-foot-centers in areas where coverage discrepancies are apparent.

Table 9 Mitigation Costs with Adaptive Management Added

Mangrove Alternative	Construction Cost of Mitigation	Monitoring and Adaptive Management Costs	Total Costs
WLP Mangrove Enhancements	$1,416,249	$40,300	$1,496,849

6.0 MITIGATION FOR UNAVOIDABLE IMPACTS TO HARDBOTTOM HABITATS

6.1 Determining Mitigation Needs for Hardbottom Habitats

A Habitat Equivalency Analysis (HEA) takes into account the quantification of ecological services lost from an impact as well as the interval of time necessary for habitats (those either impacted or those proposed for mitigation) to reach optimum performance. Hence, it can be used to determine the appropriate quantity of compensatory mitigation (King 1997). HEA has been used in other USACE-SAJ projects, and its application in this project has been approved for single-use in this project by the USACE National Ecosystem Planning Center of Expertise.

The HEA method (as detailed in NOAA 2000) was used to calculate mitigation requirements (in acres) for reef and hardbottom impacts associated with the proposed project (see DC&A and USACE 2014; i.e., Appendix E-3). The HEA took into account both anticipated impact acreages for various habitats (inner, middle, and outer reefs, as well as channel wall impacts and indirect impacts (see DC&A and USACE 2013 for details) and recovery times to calculate the overall loss of habitat function that occurs from the time a new impact occurs to the time of full functional recovery. Projected impact acreages were classified according to the various relief/profiles and habitat types in the affected areas. Therefore, in effect, several HEAs were conducted, and then resulting acreage assessments combined to arrive at the total mitigation acreage required. The results of the analysis are provided in DC&A and USACE (2014; i.e., Appendix E-3), which details the assumptions (form of recovery function, relative functionality at time "0" and at the end of recovery period, interval of recovery period for each habitat type impacted, etc.) that were used in the analyses. Finally, for performance of an HEA, assumptions concerning mitigation measures must be provided. Due to previous experience with similar projects in southeast Florida, USACE assumed that artificial reef construction using quarried or dredged rock would be the most likely and feasible mitigation, so that was selected as the candidate mitigation for which output data would be configured.

For the HEA runs, the potential direct impacts were broken into three direct impact components and the indirect impact component. There are three potential direct/incidental impact components. Depending on dredging methodology(ies) chosen by the selected contractor, all three of these components may occur, or some combination of the three may occur. For a description of each component, please review Section 4.5.1 of the "Mitigation Requirements Analysis for Hardbottom Resources Associated with Port Everglades Harbor Navigation Improvements". Table 10 below details the acres of impacts associated with each component and the required mitigation Serve Acre Years (SAYs) for each of the components. In addition to these impacts, hardbottom habitats surrounding the would-be new channel limits (up to 150 meters away) that may be affected by sedimentation and/or turbidity. The indirect effects associated with sedimentation/turbidity are included below. Finally, to complete the HEA, a candidate mitigation scenario must be assessed, using its estimated value (and time required to reach its optimal functionality) in calculations. The candidate mitigation project subjected to evaluation was construction of artificial reef including installation of coral colonies. For this mitigation alternative, the mitigation requirement is the creation of hardbottom habitat through construction of artificial reef structures and outplanting of corals propagated in nurseries into degraded habitats in Broward County. The above-described analysis relates only to the results for use of artificial reef installation (using dredged or quarried rock/boulder) as the mode of mitigation (HEA results are necessarily linked to the type of mitigation proposed).

The direct impacts and resulting mitigation requirements associated with Component 1 has been adopted to represent the primary mitigation plan. Mitigation for Components 2 and 3 is considered a contingency (given evidence that anchor/cable impacts are typically minimal and temporary; and the impacts associated with downslope rubble movement are expected to be minimal), and will only be carried out if actual damages to reefs occurred and is verified by post-construction surveys.

Table 10 Hardbottom Impact Components and Associated Required Mitigation

Impact Component	Acres of Impact	Service-Acre-Years of Mitigation Required
Component 1	15.330	722.043
Component 2	15.040	380.061
Component 3	6.368	299.933
Indirect with Comp 1 & 3	109.080	26.997
Indirect with Comp 1 & 2	89.760	22.216

6.2 Hardbottom Habitat Mitigation Alternatives

There have been multiple efforts to provide interagency coordination regarding all regulatory issues pertaining to the proposed project, the majority of which are detailed in the main text of the Environmental Impact Statement (EIS) and are hereby incorporated by reference. In addition to those efforts and under direction of USACE, the Port Everglades Reef Group (PERG) was formed. The purpose of PERG was to provide scientific, technical, and logistical guidance and expert advice regarding provision of mitigation for impacts to hardground and reef habitats due to navigation improvements at Port Everglades. The group held four meetings onsite at the Port's offices. PERG was tasked with this objective in absence of a known mitigation budget and without knowledge of the timeline under which impacts and mitigation were to take place. PERG was informed that funds for mitigation construction and related measures, except monitoring, would be included in the federal budget along with costs for navigation improvements. PERG discussed not only how to best carry out traditional means of mitigation (e.g., artificial reef construction and monitoring), but also methods that are somewhat more cutting-edge, such as coral head translocation and reef restoration/enhancement. Specific issues, such as additional baseline studies, monitoring, and artificial reef siting and construction materials were also discussed, as was whether the mitigation policies of the various regulatory agencies could allow for certain means of mitigation. The Draft Compensatory Mitigation Recommendations of the Port Everglades Reef Group for Navigation Improvements at Port Everglades Harbor (PERG 2004) is attached in Appendix E-4. The mitigation plan described in the following pages does not take into account many of the draft recommendations of PERG, though some recommendations made by PERG may be utilized for the final mitigation plan if cooperating, regulatory, and natural resource agencies; the local sponsor; and user groups agree on their utility, value, and compliance with mitigation policies. One notable recommendation of PERG that will be implemented is the transplantation of corals larger than 25 cm in diameter/height to the mitigation site (see DC&A and USACE 2013, revised by USACE in February 2014, for details).

The following reef mitigation alternatives were reviewed for feasibility, either during and through PERG, or during subsequent plan formulation discussions/correspondence with regulatory agency staff, academic professionals, and consultants:

1. Removal of tire debris (the "Osborne tire-reef") between the middle and outer reef line

Approximately 2,000,000 tires were "disposed of" at sea in the 1970s to create fishing reefs. The tires were bundled together with metal bands that over time have rusted and broken, releasing the tires (Figure 4). The tires also did not perform as estimated from a marine life colonization standpoint. The tires are now mobile in the marine environment, and during storms, they wash into the seaward side of the middle reef causing ongoing habitat degradation. Since 2001, a variety of efforts has been made to remove the tires including projects conducted by NOVA University and Broward County, in concert with the US Army and US Navy divers. It is a time-consuming effort that must be carried out by divers, as mechanical equipment would risk damage to the reefs adjacent to the tire field. The previous efforts were funded through Coastal America Grants, and the project has received a Coastal America Award. However, there are still approximately 700,000 tires remaining to be recovered and funding remains a significant limitation to project implementation (K Banks, BCEPD, pers. comm. 2012). This alternative was removed from further consideration because to gain any ecological function of the benthic habitat, nearly all the tires would have to be removed (any remaining tires could drift to other areas and damage reefs). In addition, the resulting functional gains that could be provided would be less than many of the other available mitigation options. Furthermore, the minimal gains would come at a much higher cost than many other options.

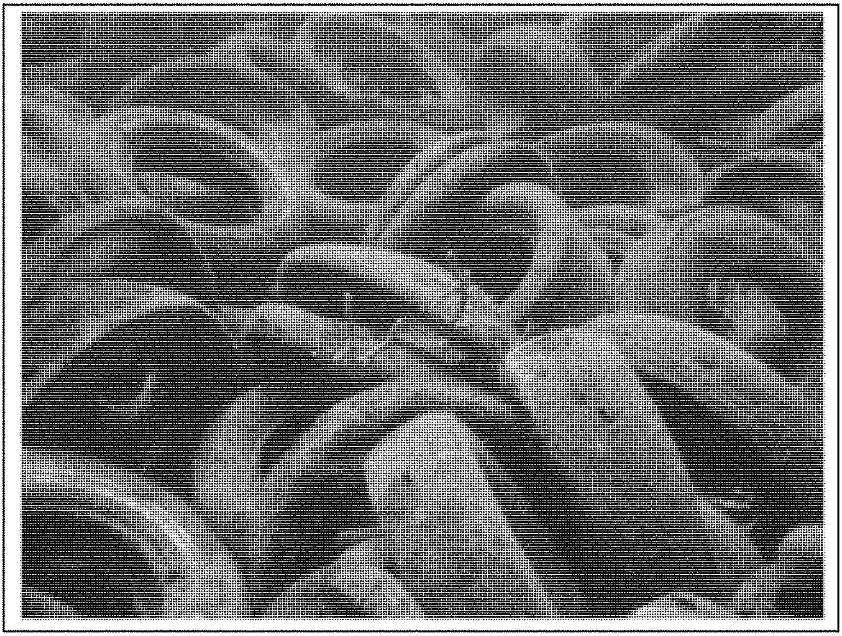


Figure 4 Ocean Floor Covered with Tires: "Osborne Tire-Reef"

2. Artificial reef placement on tire "reef"

Broward County proposed for use as mitigation the placement of artificial reef materials on top of the Osborne Tire Reef (discussed above) to stabilize the tires and prevent them from continuing to move shoreward and impact the middle reef. In theory, the materials would prevent middle-reef damage as well as provide usable hardbottom substrates for reef species colonization. The proposed plan involves the use of limestone boulders, placed over the "tire reef" stabilized with a tremie pour of specialized marine concrete (a "tremie" concrete placement method uses a pipe through which concrete is placed below water level) around the boulders. Each area will be constructed by first placing a layer of boulders onto the seafloor directly over the tires. Concrete will be poured around this layer, filling interstitial spaces and attaching the layer to the sides and bottoms of the adjacent seafloor to the greatest extent possible. The concrete fill will terminate just above the boulders' widest sections to stabilize the boulder layer and provide for secure placement of the next layer. The concrete surface will also be rough to allow for improved adhesion to the upper layer. Layers will be constructed above one another. When restoration is completed, the surface will consist mostly of limestone boulders, with concrete interstitial fill below the boulders' crests. The limestone boulders used in repair will weigh from three to five tons and generally feature diameters of about four feet. Once completed, each reef-repair unit will be a solid structure. The interval required to reach substantial functional productivity of this alternative is estimated to be 30-50 years. This would be shortened to 20-30 years if corals are transplanted from the impact area to the artificial reef.

The relative benefits of this mitigation alternative are that units would be secured to the seafloor, would stabilize the tire-reef "understory," and they would have moderate functional values at installation. Drawbacks include a high cost per acre of construction (due partly to the need for commercial divers during construction), low aesthetic value relative to nearby natural hardbottom reefs, a lack of beneficial characteristics of tremie-pour (concrete poured through a large metal hopper and pipe) compared to natural limestone, and uncertainty regarding whether the structural integrity of the tire-reef could support artificial reefs on top of it.

3. Reef enhancement through water quality improvements

During the PERG discussions, the discussion of water quality improvements was raised as a potential mitigation option, particularly the relocation and/or retrofitting of broken or inadequate sewage outfalls. While the amount of money required to construct mitigation for unavoidable impacts associated with Port Everglades may be significant, it is not sufficient to retrofit or relocate underwater sewage outfalls in Broward County, and USACE does not have a mechanism to set aside the funds and hold them until the remaining funds necessary to complete this effort could be obtained by the local sponsor, county government or other entity. Additionally, it is not clear how success of this mitigation option would be demonstrated. USACE mitigation policy requires that success criteria be established for any mitigation option, and it is not clear how water quality improvements would be monitored, what the geographic area of monitoring would be or how long monitoring would have to be in place to answer the success question. In addition, in 2008, the Florida Legislature passed, and the Florida governor signed a bill requiring that ocean outfalls in the vicinity of coral reef habitats be shut down and decommissioned, including the outfalls In Broward County. According to the law, by 2018 the existing outfall discharges would meet advanced wastewater treatment and management requirements and by 2025, 60% of the facility flows would be reused for beneficial purposes, and use of the outfalls for wastewater disposal would be restricted to wet weather flows from permitted reuse systems. Based on the current schedule, the earliest that construction activities could be initiated for Port Everglades is 2017. This is one year before the retrofit of the existing outfalls for compliance with the law, and it is unlikely that institution of this measure by the Port and USACE could be complete within the required legal timelines. Due to these limitations, it was determined that this was not a viable alternative for mitigation for the Port Everglades project.

4. Reef enhancement

A previously impacted area on the outer reef, south of the planned channel expansion, was discerned using Laser Airborne Depth Sounder (LADS) data. This area was identified as a possible reef enhancement mitigation option by the interagency working group. During work performed for the DC&A (2009) benthic habitat assessment in early 2006, this area was documented to have large boulders and large amounts of rubble (Figure 5). The source and age of the impact is unknown. The results of the survey indicated this area supports some of the highest hard coral densities on the third reef and similar soft coral densities and numbers of species as the impact site (DC&A 2009), which may mean, that although it is "previously impacted", it is not in need of enhancement. Based on that assessment, it was determined that this was *not* a viable option for mitigation for the Port Everglades project.

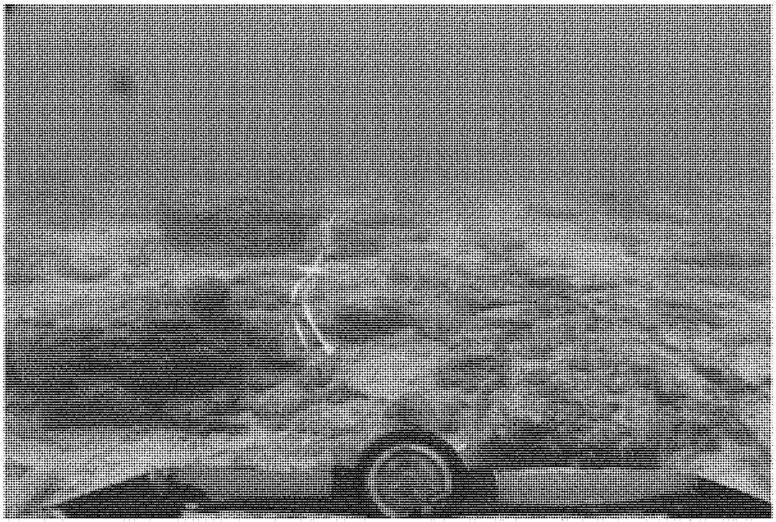


Figure 5 Previously Impacted Area on Outer Reef, South of the Planned OEC Expansion

5. Reef research

During PERG meetings, one or more participants inquired whether some mitigation funds could be used to perform research on reefs, or even just to construct artificial reefs with various materials or in various configurations such that research could be performed, even as the reefs provided targeted ecological functions. This would be considered "value-added" mitigation, where a secondary purpose could be achieved that may have indirect benefits for reef system design in years to come.

USACE mitigation policy requires that mitigation replace lost habitat function and that the success of the mitigation be measureable using success criteria. Although installation of artificial reefs meets this requirement, research does not specifically and directly replace lost habitat function, although the results of research may help resource managers to better assess impacts and create viable habitats for future projects. However, because the functional ecological benefits for the part of this alternative relating to research cannot be directly quantified, this alternative was determined to not be a viable option for mitigation for the Port Everglades project.

6. Repair of grounding sites and subsequent coral installation (transfer from impact sites)

The Southeast Florida Coral Reef Initiative (SEFCRI) and Broward County have identified approximately ten (10.6) acres of injured (unrestored) coral-hardbottom habitat that resulted from damage from vessel groundings. These are in an area north of the Port Everglades OEC that was formerly used as a commercial anchorage (Figure 6). FDEP contracted with NOVA University to prepare an assessment of the grounding sites and their current recovery status (Gilliam and Moulding 2012). A total of ten sites have been documented and are under consideration for use as mitigation for impacts due to implementation of improvements at Port Everglades. Restoration at these sites will include a combination of rubble stabilization, filling depressional areas, restoration of reef structure and complexity, and filling and sealing reef fractures. In addition, rubble and small rocks from the grounding sites will be used to fill holes in the seabed. The interval required to reach substantial functional productivity of this alternative is estimated to be 30 years. This would be shortened to 10-20 years if corals are transplanted to restored reef structures from the impact sites.

The benefits to this alternative include the following:

- Stabilization of rubble and fractured hardbottom
- Relief provided to flattened reef structure
- Habitat would be directly secured to seafloor
- Creation of enhanced habitat that is aesthetically similar to adjacent, unimpaired natural hard-bottom reef structures
- Integration of restored areas into existing, nearby, natural reef structure
- High functional value reached after a short time interval

The major drawback of this alternative is high cost due to intensive labor associated with diving (commercial and scientific).

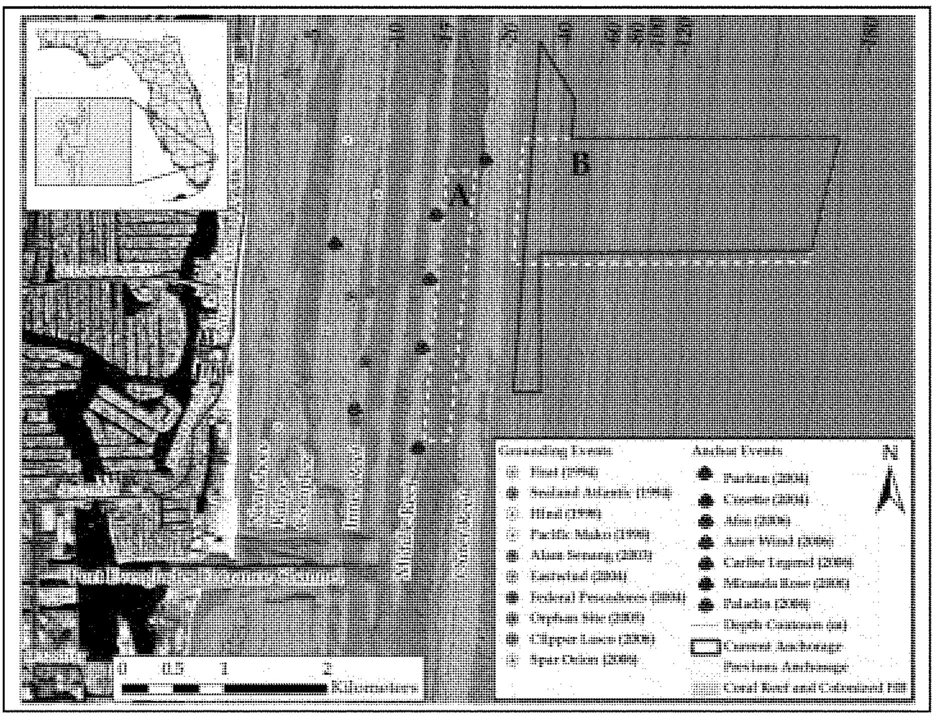


Figure 6 Location of Groundings Offshore of Port Everglades (Gilliam and Moulding 2012)

7. Removal of previous dredged materials from habitat north of the channel

In the nearshore ridge complex, adjacent to the north edge of the existing channel is an area where dredged material had been side-cast for a 1962 Port expansion project (Figure 7). For this mitigation alternative, the deposited material would be removed to expose hardbottom substrates and rock would be installed in these areas to facilitate colonization. Other than a study conducted on the western-most portion of the previously dredged material, there is little known information available about the on-site conditions and whether this could be developed into a viable mitigation alternative. Additional studies would be necessary to determine feasibility. For that reason this mitigation alternative was removed from further consideration.

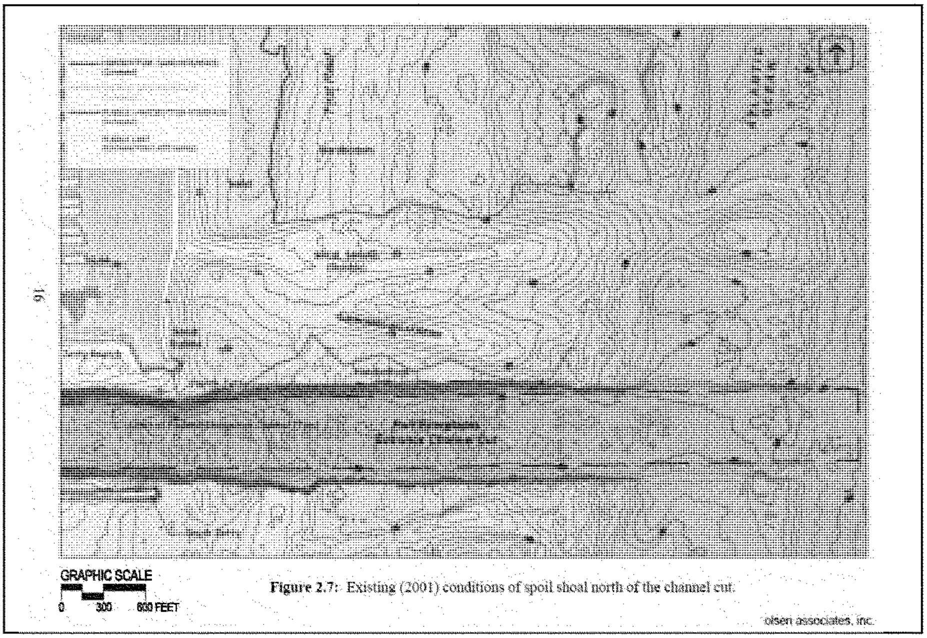


Figure 7 Location of Spoil Shoal Parallel to Port Everglades OEC (Olsen Associates 2004)

8. Artificial reef creation using quarried or dredged rock

Where restoration and enhancement of reef resources are not available for use as mitigation, hardbottom creation has traditionally been offered (in this geographic area and where similar habitats are affected) as compensation for impacted habitats and lost ecosystem functions.

For the proposed compensatory mitigation for impacts at Port Everglades, the configuration of artificial reef materials will resemble, in profile and in functionality, to the maximum extent practicable those habitats impacted. Since new reef impacts would take place at water depths of approximately 40 to 45 feet (second reef line) and 50 to 55 feet (third reef line) for the channel expansion at Port Everglades, it was suggested that these two depth zones should be used as mitigation sites to achieve in-kind mitigation. Indeed, the use of in-kind mitigation immediately adjacent to the impact site is one of the major benefits to this mitigation alternative. Also, the amount of "high-relief" reef and "low-relief" hardbottom that could be created would be in proportion to the impacted sites, unlike many of the other mitigation options. Mitigation reefs associated with the Port of Miami expansion in 1993 (the last deepwater port expansion with mitigation creation available for assessment) were examined to determine if the mitigation reefs provided similar habitats, species assemblages, and functions as the impact area. This was in fact the case, after seven years of the mitigation reef being in place (and without any transplants of corals to the mitigation reef). Other benefits of use of this mitigation option include the relative stability (on the seafloor) of quarried or dredged limestone/rock; relative ease of construction; and relative low cost.

This plan involves the deployment of piles of limestone that have been either quarried and transported to the mitigation area, or dredged from the channel construction areas. The piles will be configured in rows that are parallel to the existing reef tracts. Two layers of boulders will comprise these piles, given a vertical dimension of approximately 6 to 8 feet of relief. Low relief areas will comprise only one layer of boulders.

The interval required to reach substantial functional productivity of this alternative is estimated to be 30-50 years. As proposed, coral colonies greater than 10 cm (up to 11,502 colonies) in diameter and free of disease and boring sponge would be transplanted from the impact area to the mitigation sites, which would be prepared in advance of dredging.

Drawbacks to this alternative are that the artificial reefs, as proposed above, are not as aesthetically pleasing as adjacent natural hard-bottom reef structures, they do not include a tremie concrete pour that would bond them even more securely to the seafloor, and they would remove some softbottom (sand) habitats adjacent to existing reefs when the rock is placed on the sand. Finally, just after completion of installation, the functional value of the reefs is relatively low (compared to restored/enhanced reefs or boulders to which corals have been transplanted). Additional details regarding this alternative are found below.

9. Artificial reef creation using modular materials

Creation of artificial reefs using modular materials instead of quarried or dredged rock is another alternative. This alternative is identical to the Reef Creation alternative discussed above, but for the use of modular reef materials. This alternative utilizes modular reef components that are created on-shore and moved to the reef placement site. Modular reef habitat construction as a compensatory restoration alternative would consist of using established technology to construct and place cement reef-replication modules in a manner to provide a range of desirable ecological services. For example, a modular reef can be designed to maximize vertical profile, surface area for settling organisms, crevices for shelter, foraging habitat for pelagic organisms, or some combination of services such as these. Prefabricated reef modules have been used in the United States (including Broward County) to restore coral reefs impacted by vessel groundings and deployment of telecommunication cables. The creation of an artificial reef that mimics low relief hard-bottom coral reef can be designed for both aesthetics and habitat function. A project to construct and place cement reef-replication modules in a shallow or deep hard-bottom environment could be located in one or more favorable settings north or south of the project footprint. Another benefit is that upon installation, they have a moderate (vs. low, as in the rock reef creation alternative) functional value.

Costs for this alternative are relatively higher due to (1) on-shore labor to create the modules, (2) land-based, as well as sea-based, transportation costs, and (3) diver labor necessary to place the modules on the seafloor. However, the benefits include ease of construction and the secure placement of modules on the seafloor.

The interval required to reach substantial functional productivity of this alternative is estimated to be 30-50 years. Coral colonies greater than 10 cm (up to 11,502 colonies) in diameter and free of disease and boring sponge would be transplanted.

10. Coral propagation and active species enhancement

NOAA Fisheries (National Marine Fisheries Service, or "NMFS"), a cooperating agency with USACE for development of the Environmental Impact Statement (EIS), independently estimated that the tentatively selected plan would impact 137.83 acres of coral, coral reef, and hardbottom (collectively referred to here as "reef": 20.34 acres of coral reef in the channel and 117.49 acres of coral reef located outside the channel) based on an analysis utilizing the 2001 LADS survey (USACE used 2008 LADS data). In May 2013, NMFS recommended that USACE mitigate these impacts by propagating coral colonies at in-water and land-based nurseries and then outplanting the colonies to suitable recipient sites on the reef tracts. NMFS estimates this approach would require 20 years to complete and would cost approximately $35.6M to $42.3M (including risk contingencies).

NMFS's recommendation is based on successes of coral propagation and enhancement programs in Atlantic and Caribbean waters. Scientifically vetted practices for nursery propagation, outplanting, and monitoring have been developed and used by coral nursery managers in the Florida Keys, Broward County, Puerto Rico, U.S. Virgin Islands, and other Caribbean islands to reproduce *Acropora* spp. asexually (e.g., Johnson et. al 2011). Typically, small fragments less than five centimeters (cm) in diameter are collected from the reef and held in an underwater or tank-based nursery environment through their juvenile life-stage. Offshore nurseries are sited based on a number of factors including habitat feasibility and water-quality conditions, potential for future impacts, and permitting status/considerations. Once the stock nursery population is established, no more coral is collected from natural reef communities. The physical and genetic origin of each coral is tracked from fragment collection to ensure that both nursery and outplanting operations are done in a biologically responsible way (with respect to colony fitness and appropriateness). Regular maintenance is performed on nursery structures and the corals themselves to ensure all are free of coral competitors and predators. Once coral fragments have grown to a size where the probability of survival on natural reefs has increased to an acceptable level (this usually requires 12 to 18 months), the corals are outplanted. Decisions regarding which species (in addition to staghorn coral) are propagated and outplanted and relative species richness (based on relative percent-cover, and/or relative population densities) among all species would be based on findings from the most recent peer-reviewed literature at the time the project is funded. Additionally, outplant recipient sites would be selected using a strategy that maximizes likelihood of outplant survival while minimizing risk from natural and human disturbances.

Using a type of Habitat Equivalency Analysis, specifically "resource-to-resource" equivalency analysis, NMFS estimated that 195,000 to 250,000 corals need to be outplanted from nurseries to offset the impacts to coral from expanding the Port's OEC. These costs are included in the budget for this alternative. In addition to eventually establishing those colonies on recipient sites, NMFS also assumes that preconstruction avoidance and minimization measures related to coral translocation are taken (these costs are *not* included in the budget for this alternative). These include the following:

- Relocation of all corals listed under the Endangered Species Act from impact areas, regardless of size.

- Relocation of a subset of massive corals and all corals proposed to be listed under the Endangered Species Act that are 5 cm or larger.
- Relocation of all other corals greater than 10 cm diameter.

The proposed coral propagation and outplanting program is based on utilizing existing NMFS programs to support the implementation of the project in partnership with local resource agencies (e.g., FDEP), academic institutions (e.g., NSUOC), and other coral restoration partners in the local area. One benefit of this alternative is that it is designed to maximize the chances of successful natural coral reproduction; larval transport; settling and colonization into new areas; and genetic mixing required for survival and recovery of the species. Furthermore, this proposal is consistent with the NMFS Acropora Recovery Strategy (under development) and other coral recovery plans for coral species that may be listed under the Endangered Species Act. The entire draft proposal for this alternative is located in Appendix E-5.

11. Blending of components from Alternatives 6, 8, and 10 (Preferred Mitigation Option)

This alternative is a hybrid of the USACE preferred plan (Alternative 8 - artificial reef creation using quarried or dredged rock), and NOAA's preferred plan (Alternative 10 - coral propagation and active species enhancement), and portions of Alternative 6 (repair of grounding sites and subsequent coral installation).

Under this hybrid plan, at least five (5) acres of boulder-based artificial reef would be constructed. Approximately 2.03 acres of those five acres would receive coral transplants that will be relocated from dredging impact areas and transplanted to boulders at a density commensurate with the impact site (i.e., 1.4 corals/m²). Boulder-based artificial reef would be constructed without coral transplants, for the balance of the five acres, i.e., 2.97 acres.

The remaining mitigation would be in the form of direct enhancement of partially degraded reef sites proximate to, but not within or adjacent to, the proposed project footprint for the expanded OEC. The proposed reef mitigation project would enhance degraded reefs by outplanting regionally appropriate corals and sponges at a density commensurate with those areas that will be impacted. The organisms for outplanting would be sourced from corals and sponges "of opportunity" or propagated in ocean-based or land-based coral nurseries operated under contract associated with the project for a period of 11 years. As would be the case for construction of any federally sponsored mitigation construction project, the work will be carried out by a contractor selected via an RFP process.

The coral propagation contractor shall be required to monitor the outplanted propagated corals for a three-year period for each outplanting area. After three years of monitoring of each outplanting area, the final success determination for that outplanting area will be made and that area will no longer be monitored if criteria are met.

Outplanted nursery corals shall be monitored for survival, and corrective actions shall be taken, if necessary, to ensure survival remains above 80% (see the Monitoring and Adaptive Management Plan found in Appendix E-6). Survival shall be compared to control sites with similar species composition as the outplant sites in order to detect any region-wide changes or stochastic events like disease or a hurricane. The project sites shall reflect similar coral survival as the control sites for the outplanted colonies. Control sites shall be selected by the contractor, reviewed by the USACE and the Adaptive Management Committee, and approved by the Contracting Officer.

Based on HEA, the total number of outplants was determined to be 103,191 corals. An additional 20% will be available as a contingency if any corrective actions are required pursuant to adaptive management. These 103,191 supplemented colonies would improve local reef structure and function at maturity. More importantly, the outplanted corals would increase the likelihood of successful sexual reproduction and contribute directly to the pool of coral larvae available to colonize adjacent reefs. In order to maximize the return of lost services, the agencies propose to outplant a regionally appropriate mix of both fast- and slow-growing, massive, branching, and octocorals as well as habitat-forming sponges as part of the mitigation project.

6.3 Incremental Cost Analysis Results for Hardbottom Habitat Mitigation Alternatives

6.3.1 Expected Cost of Alternative Hardbottom Habitat Mitigation Plans

The estimated costs of the five practicable mitigation alternatives to provide compensation of ecosystem services due to unavoidable impacts of the Recommended Plan (LPP) are shown in the column headings of Table 11. The table also lists the impact acreages per habitat type, and the resulting mitigation requirement (in acres) for each of the candidate mitigation alternatives. Finally, along the top row, the table also compares the recovery rates (in years) for seafloor habitats and channel wall habitats that were used in the HEAs. Total mitigation cost ranged from approximately $23 million to $72 million among the five alternatives.

6.3.2 Hardbottom Habitat Mitigation Benefits

The basis for determination of benefits will be one acre of restored or created hardbottom habitat. USACE would create 5 acres of artificial reef, with up to 11,502 corals relocated from the impact area to the artificial reef and restore 18.21 acres of degraded habitats with up to 103,191 outplanted corals.

6.3.3 Construction/ Initial Cost per Hardbottom Habitat Functional Unit

The base-year cost of each of the five, practicable, candidate mitigation plan was compared to the respective benefit (functional unit, or acre) below (see Table 12). Costs were based on FY2012 estimates (annualized values are provided in the Economic Appendix of the Feasibility Study). Artificial reef creation costs were determined from a review of actual contract award costs for the Florida Keys National Marine Sanctuary as well as the Port of Miami artificial reef construction projects. Some commenters on the Draft EIS suggested that the USACE costs were too low. However, the cost estimates were based on a review of many recently awarded contracts for large scale, deep water reef restoration and coral relocation. Costs-per-acre for the five practicable mitigation alternatives ranged from approximately $1 million to $1.5 million. Coral propagation costs were determined by an industry survey conducted by NOAA and provided to USACE.

6.3.4 Cost-Effective Hardbottom Habitat Mitigation Plan

Cost estimates for the above alternatives that were determined to be practicable (reef creation with coral outplants; reef creation on tire debris field, reef restoration in former anchorage area, and reef creation, including the modular-reef option) were calculated, and those costs were used in an incremental cost analysis. An alternative is considered cost-effective if no other alternative provides the same level of output for less cost, and if no other plan provides more output for the same or less cost (ER 1105-2-100). The table above shows a comparison of plans. The reef creation with nursery corals is not only the least cost alternative, but it also has the lowest cost per increment. Given that finding, the "reef creation with coral outplants" alternative described above was selected as the proposed mitigation plan for impacts to hardbottom habitats due to the Recommended Plan (i.e., the LPP).

Table 11 Required acres of mitigation and associated costs for Component 1 direct impacts and indirect impacts due to implementation of the Recommended Plan (48-foot *authorized* depth/ 57-foot *actual* depth)

	Impact Area (Acres)	Artificial Reef and outplant of nursery corals	Grounding Restoration Sites w/ Transplants	Artificial Reef Creation-Modules	Tire Field Stabilization w Art. Reef Creation	Artificial Reef Creation-Boulders
Time to Recovery: Seafloor/ Channel Wall (yrs)		35/50	20	50	50	50
Component 1	15.33	5 ac (2.03 w/ transplants/ 2.97 without)	18.17	46.583	46.583	46.583
Indirect reef impacts – all habitats surrounding channel	109.08	n/a	1.13	1.13	1.13	1.13
Out planted corals required		103,191	n/a	n/a	n/a	n/a
Total mitigation area (acres) required to offset impacts		5 ac (2.03 w/ transplants/ 2.97 without)	19.912	48.325	48.325	48.325
Cost per Acre		$984,699	$1,260,000	$1,320,000	$1,225,000	$984,699
Coral Relocation (Not more than 11,502 colonies)		$8,143,416	(included above)	$8,143,416	$8,143,416	$8,143,416
Coral Nursery Costs		$10,680,290	n/a	n/a	n/a	n/a
Total Mitigation Cost		$23,747,202	$25,089,120	$71,932,416	$67,341,541	$55,728,995

6.3.5 Hardbottom Habitat Mitigation Cost Based on Selected OEC Depth Option

Several alternative authorized depths were under consideration for the proposed project's Outer Entrance Channel element. These authorized depths would result in actual depths ranging (in one-foot increments) from 55 to 59 feet ("authorized" or "project" depths are seven feet less then these actual depths). Each depth would affect/impact a different amount of hardbottom habitat and hence result in different mitigation requirements. Table 13 shows what those differences are (in acres) and lists the different mitigation requirements and costs for each depth under consideration, based on the "best buy" mitigation alternative as determined above (the artificial reef with nursery coral outplants option).

Table 12 Construction/ Initial Cost per Acre of Hardbottom Mitigation

Reef Mitigation Alternative	Construction Cost of Mitigation	Benefits of Mitigation (acres)	Cost/Acre
Grounding Restoration Sites w/ Transplants	$25,089,120	19.912	$1,260,000
Artificial Reef Creation- Modules	$71,932,416	48.325	$1,488,514
Tire Field Stabilization w Art. Reef Creation	$67,341,541	48.325	$1,393,514
Artificial Reef Creation- Boulders	$55,729,004	48.325	$1,153,213
Artificial Reef and outplant of nursery corals	$23,747,202	23.210 (5 artificial + 18.21 enhancement)	$1,023,145

Table 13 Incremental Mitigation Construction (Initial) Costs for Hardbottom Impacts

Actual **OEC dredge depth increment, including +7'+1'+1' for safety (and** ***Authorized*** **Depth)**	**Mitigation Required (Service-Acre-Years)**	**Mitigation Cost for Cost-Effective Mitigation Alternative (Artificial Reef and Nursery Coral outplants)**
-59 ft (-50)	869.970	$25,901,001
-58 ft (-49)	Not determined	Not determined
-57 ft (-48)*	794.236	$23,747,202
-56 ft (-47)	752.250	$22,554,901
-55 ft (-46)	702.170	$21,102,235

*The Government's Recommended Plan depth (also corresponds to Locally Preferred Plan depth)

6.4 Proposed Mitigation Plan for Hardbottom Habitats

6.4.1 General Artificial Reef Considerations

Artificial reefs are used to mitigate for impacts to natural hardbottom habitats as a result of various anthropogenic activities along the coasts (Zimmer 2006). Artificial reefs have been used as mitigation for beach nourishment projects, dredging projects, and telecommunication cable placement projects that affected natural reef or hardbottom.

Artificial reefs have been used successfully for many years to mitigate impacts in sheltered waters (Duffy 1985 and Davis 1985) or in relatively deep water offshore (Mostkoff 1993). Reef deployments in shallow, open, coastal areas present special challenges in the wave stability of materials and burial by sand movements in this very dynamic habitat.

Several factors are important to consider when designing a mitigation project using artificial reefs, including site selection (vis-à-vis position in the environmental landscape and relative physical and biological factors), longevity, and achieving design elements that mimic the natural system so that the project replaces, as closely as practicable, the functions lost due to project impacts (i.e., "in-kind" mitigation).

Site selection is an important factor in artificial reef success. Depth, substrate suitability, geo-spatial orientation, and connectivity with other artificial or natural reefs must be considered when selecting a site for artificial reef placement. Since the biological composition of reefs is driven in part by depth and associated factors such as light attenuation, the depth of artificial reef should be similar to the impacted natural reef. The composition (and depth to bedrock, if the overburden is sand) of the substrate on which the rock is placed must be sufficient to support artificial reef structures. Artificial reefs placed in areas having a thick overburden of sand have been documented to sink and thereby lose their functionality as reefs. Ideally, artificial reefs should be placed in an area with a thin veneer of sand over limestone or bedrock. Artificial reefs should be placed in order to mimic the geospatial aspects of the natural reef as much as possible. For example, if the long axis of natural reefs runs in a north-south direction, then artificial reefs should be designed and placed using the same geospatial orientation. Finally, a candidate site's biological connectivity should be considered when designing and placing artificial reefs for mitigation. The artificial reefs should mimic the connectivity of the natural reefs as much as possible. Biological connectivity also relates to potential exposure of artificial reef structures to pelagic larvae, such as might be carried by the Gulf Stream.

Mitigation reefs have often been required to be built in the immediate vicinity of the natural reefs impacted by construction activities. In areas where the habitat that was impacted was the only habitat in the area, this approach has merit. A guiding principle of artificial reef development has always been that reefs should not be deployed immediately adjacent to productive reef habitats. From a fisheries standpoint, reefs placed in non-reef habitats are biologically more productive as they are coupled with foraging habitats that are unexploited by other reef fishes (Bortone 1998). More importantly, the shifting of reef materials during storms may severely damage adjacent natural habitats. For this reason, the Florida Artificial Reef Development Plan (Myatt and Myatt 1992) prohibits material from being placed within 100 yards of "live bottom" areas, such as nearshore hardbottom. Following Hurricanes Andrew, Opal, and Erin, it was found that even massive materials in relatively deep water were moved or broken up by tremendous wave forces (Lin 1998, Turpin 1998). The possibility exists that less massive materials in much shallower water could shift and damage adjacent natural habitats. For the above reasons, sites selected for mitigation reef construction should have no significant areas of natural reef within 100 yards and no reefs should be placed directly seaward and immediately adjacent of any significant area of natural reef.

6.4.2 Artificial Reef Siting, Materials, and Design

Five acres of created reef habitat will be designed and placed to replicate the impacted natural habitat of the middle and outer reefs. Two types of mitigation reefs will be constructed: High Relief, High Complexity (HRHC) reefs (exceeding three feet of vertical relief) and Low Relief, Low Complexity (LRLC) reefs (approximately three feet of relief). The HRHC reefs are intended to mitigate for impacts to high-relief habitat (i.e., linear or spur-and-groove reefs) and the LRLC reefs are intended to mitigate for impacts to lower relief reef (i.e., pavement or channel wall) and hardbottoms outside of the project footprint (i.e., in the indirect effect area). The two reef types will be deployed in acreages proportional to direct impacts expected to each type of natural reef habitat (where impact habitat types were based on data collected in 2006 (DC&A 2009) and published classification systems): 31% of the artificial reef will be LRLC (approximately 1.55 acres) and 69% will be HRHC (approximately 3.45 acres).

Several areas are under investigation to serve as sites for installation of artificial reefs (Figure 8). USACE intends to partner with Broward County to identify the best location for placement of the five acres of artificial reef. Geotechnical investigations and other reconnaissance (including environmental) will be necessary to determine precisely the best position(s) for reef structures to be installed. Appropriate members of Broward County, FWS, NMFS, FWC, EPA and DEP staffs will be consulted prior to final siting.

Limestone rock excavated from the STB, MTB, IEC, and the OEC may be used in reef construction and, if necessary, supplemented with quarried limestone. If the selected contractor chooses to use project-produced rock, they may commence excavation *inside* the harbor, transporting the material offshore for mitigation construction, and then proceed to dredging the entrance channel; i.e., dredging and reef installation will occur simultaneously. Alternatively, the construction contractor will be allowed the option of purchasing quarried native limestone in lieu of using the material from within the project boundaries. Contract specifications/requirements may be stated in the following manner, as they were for another recent federal project in South Florida:

> "The sites [i.e., dredge sites/project components] may be used in any combination to provide the minimum area for both low-relief and high-relief reef and may be used in their entirety if desired. Suitable materials for use in the reef mitigation areas shall consist of rock excavated from the project or native limestone quarried from Palm Beach, Broward, Dade, Monroe, Martin, Glades, Charlotte, Lee, Hendry, and/or Collier Counties. Rock particles shall measure a minimum of 36-inches in length by 36-inches in width, the third dimension remains variable. The stone shall be free from components, minerals, cementing or bonding materials or structural defects that might contribute to spalling or breakdown from handling and placing. The Contractor shall be responsible for removal of all rejected reef construction materials from the staging area, barges or reef. If substandard materials are placed on the reef, the Contractor shall be responsible for removing those materials and replacing them with acceptable reef material or shall place additional stone to achieve the minimum areas for both high-relief and low-relief reef, as directed by the Contracting Officer."

HRHC reefs will likely consist of limestone rock boulders from 1.0 to 10.0 ton each, having a minimum density of 140 pounds per cubic foot. The material will be deployed in shore-parallel strips 50-100 feet wide to mimic the orientation of typical natural reefs. This reef design will have a vertical relief of 6-8 feet and boulders will be partially stacked to provide the maximum structural complexity and to provide refugia for cryptic and reclusive species. As interstitial sand patches associated with reef habitat are thought to be important in the ecological function of the reef habitat, the reef footprint will contain approximately 20% open sand surface. If used, quarried marine limestone boulders averaging 4.25 ft. diameter will be individually placed on the seafloor. All boulders will be placed such that they will be in contact with each other, interlocking to form a compact mass. Two layers of boulders will be used to create a high-relief structure that somewhat mimics the surrounding reef environments.

Temporary buoys delineating the deployment strip will mark areas for deployment. Corner buoys for the sites shall be placed using DGPS with sub-meter accuracy. Natural limestone provides an ideal substrate for the establishment of a reef community. An additional advantage of limestone rock boulders is aesthetic. Once colonized by the reef community, the reef is almost indistinguishable from a natural reef, enhancing its value as a recreational resource. HDHC reefs are intended to provide persistent habitat with higher complexity and habitat diversity than typical natural nearshore hardbottom reefs.

For the proposed compensatory mitigation for impacts at Port Everglades, the configuration of reef materials will resemble, if not in profile, at least in functionality, those habitats impacted. The mitigation acreage required per type of impact is detailed in Table 11 which was partially adapted from DC&A and USACE (2014); subcategories for middle and outer reef mitigation requirements were based on the fractions that those types comprised of the middle and outer impact category.

It should be noted, that it is unlikely that high-profile reef would completely cover the area designated for such hardbottom habitat. A more likely scenario would be that open, sandy spaces will surround the "rock-pile-rows" to increase habitat variability and increase the exposure of the reef to sea currents and migratory species.

As noted above, transplantation of corals (larger than 10 cm in diameter) from the direct impact area to the new installed substrates will be carried out. This will speed the increase in habitat value of the mitigation sites.

PORT EVERGLADES BORROW AREAS FOR REEF MITIGATION

Borrow Area	Acreage		Av. Widths*	AV. Depths**	Depth Range	Distance from center of Borrow Pit to Channel Entrance	
(ID)	(acres)		(ft)	(ft)	(ft)	(ft)	(miles)
BA 1C	112		1000	36	35-48	81250	15.39
BA 2C	224		600	35	30-45	67800	12.84
BA 3C	78	top	150	40	36-45	67400	12.77
		mid	1050				
		bot	430				
BA 4C	46		300	40	36-47	53800	10.19
BA 6C	36		400	40	35-45	38500	7.29

* average widths obtained from GIS mapping tool
** average depths obtained using borrow area post dredge survey maps and GIS mapping tool

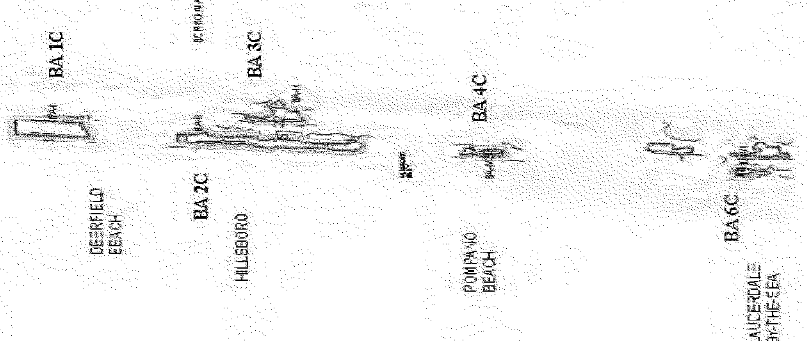


Figure 8 Proposed Artificial Reef Installation Sites, Broward County

6.4.3 Reef Enhancement Considerations

NOAA Fisheries provided technical assistance (provided in this subsection section and the next) to USACE on the approach to mitigate hardbottom impacts by (1) rescuing corals and other reef species of opportunity, (2) propagating coral colonies within ocean-based and land-based nurseries, and then (3) outplanting the colonies to suitable sites off the Broward County coast. A technical committee will be established comprising NMFS, USACE, and other partners implementing the project. The implementing partner will have the authority to take minor corrective actions. However, major corrective actions (e.g., outplant site abandonment) will be reviewed by the committee which will then recommend actions to USACE. The committee will form after the Port Everglades Harbor Navigation Project has been authorized and funded. An implementation plan will be developed by this committee and throughout the project tenure the committee will meet regularly and have the option to convene on an as-needed basis. The committee will define what constitutes a minor versus a major corrective action and determine if the monitoring duration should be extended. For example, minor adaptive management actions may reset the monitoring interval by six months and major adaptive management actions may reset the monitoring interval by 18 months.

Completion of this aspect of the mitigation (outplanting) will require approximately ten years and include activities needed to "ramp-up," outplant to the reefs, and monitor the reefs under the adaptive management protocols. Ramp-up activities include expanding the existing ocean-based nurseries, creation of new ocean-based nurseries, and outplanting site selection. Because of the importance of completing this project with a mix of regionally appropriate species, coral (and other reef species) rescue will be a major component of the project during ramp-up and outplant years. Corals and other types of colonies of opportunity will be collected and added to the nursery for fragmentation and propagation and/or eventual outplanting. Five to six outplanting years would result in the enhancement of approximately 18.21 acres of coral reef at numerous sites that may range from ⅛ to ¼ acre. Outplanting may also occur at sites being restored as part of other damage response programs (e.g., vessel grounding damage response). Monitoring and adaptive management will occur throughout the project timeline and will include activities that range from responding to regular nursery maintenance to performing monitoring to ensure the performance measures have been met.

Scientifically vetted practices for nursery propagation, outplanting, and monitoring have been developed and used by nursery managers in the Florida Keys, Broward County, Puerto Rico, U.S. Virgin Islands, and other Caribbean islands to reproduce *Acropora* spp. asexually (e.g., Johnson *et. al* 2011). These best practices continue to be refined and will be integrated into the mitigation project design. Generally, small fragments less than five centimeters in diameter are collected from the reef and held in an ocean-based or land-based nursery environment through the juvenile life stage. Once the stock nursery population is established, no more coral is collected from natural reef communities. However, for this project, there may be sufficient stock of corals in existing nurseries that can be fragmented and propagated, so as to eliminate or minimize the need to collect wild stock. The physical and genetic origin of each coral will be logged during fragment collection to ensure that both nursery and outplanting operations are done in a genetically and ecologically responsible manner.

The outplanting approach will use a combination of two types of reef organisms - (1) slow-growing and (2) fast-growing. Slow-growing corals are composed of massive corals and brooding corals. Large barrel sponges (*Xestospongia muta*) are also included as slow-growing species. It will take longer for mitigation sites to reach full services using slow-growing species, but they are essential to ensuring the mitigation sites are composed of an appropriate fully functional suite of species. The source of the slower growing coral and sponges will largely be from rescue activities (also referred to species of opportunity). The faster growing reef species are primarily composed of *Acropora cervicornis*, because this species exhibits faster growth rates than other Atlantic/Caribbean coral species, reproduces predominantly via asexual fragmentation, and can be propagated efficiently using both ocean-based and land-based nurseries. While replacing coral colonies is an essential component of the reef mitigation, replacing the three-dimensional structure of the reef is also important. *Acropora cervicornis*, in addition to barrel sponges and other reef species being considered, will provide significant three-dimensional structure through their normal growth patterns. *Acropora cervicornis*, with its fast growth rates, will provide three-dimensional structure more quickly than other species.

Offshore nurseries will be sited in a manner so as to balance a number of factors including appropriate habitat and water quality conditions, decreased risk of future impacts, and permitting conditions. Once coral fragments have grown to a size where the probability of survival on natural reef has increased to an acceptable level (this usually requires 12 to 18 months), the corals are outplanted to the natural reef. The decision on which species to propagate and outplant in addition to staghorn coral and the balance among all species would be based on the relative abundances of species in the impact area and geographic appropriateness. Additionally, outplant sites would be selected using a strategy that maximizes likelihood of outplant survival while minimizing risk from natural and human disturbances.

Using HEA, it was estimated that at least 103,191 colonies must be successfully outplanted from nurseries to offset the impacts to coral from expanding the Port Everglades OEC. Corals will need to be rescued, propagated, and outplanted to meet this target. Importantly, the 103,191 outplants is the initial outplanting requirement, and does not include additional corals that may be needed as part of an adaptive management program to meet performance objectives (estimated currently at 20%). Over time, monitoring (survival) data may indicate that it is possible the amount of outplants could be reduced. The outplant species mix is expected to be a regionally appropriate species mix comprised of a relatively even distribution of fast and slower growing organisms.

6.4.4 Reef Enhancement Logistics and Outplanting Site Criteria

While not a requirement for the performance of this mitigation component, partnerships with the entities that created the existing ocean-based nurseries would result in project implementation efficiencies. The location of the ocean-based nurseries can include expanding existing nursery sites on land and offshore Broward County, which have been implemented by Nova Southeastern University, in addition to the creation of new ocean-based nurseries. Ideally, the ocean-based nurseries would be separated by distances sufficient to absorb a localized impact (e.g., anchor drag, disease outbreak, weather event). The inclusion of the land-based operations would also help minimize the impacts from damage to offshore sites. During the ramp-up phase, new offshore nursery sites will be tested and established. The fieldwork associated with the exploration of new nursery sites will also be expanded in scope to include the examination of future suitable outplant sites.

There is value in the nurseries being designed to include a variety of designs (e.g., "growout" trees, lines, platforms). For example, while the use of lines may allow the fastest coral growth, this design may also be the most susceptible to impacts from storm damage. Best practices based on the state of the science (at the time of project implementation) will inform the nursery design.

The coral propagation and outplanting project will require numerous sites that will together comprise approximately 18 acres. Selection of these sites will be done in coordination with resource agencies and partners after construction of the Port Everglades Navigation Project is approved by Congress and funds are appropriated for detailed engineering design. Table 14 includes site selection criteria guided by the distribution and status of natural reefs, based on Johnson *et al.* (2011).

Table 14 Site Selection Criteria for Outplanting Sites

- Depth should reflect depth of ocean-based nurseries, impact sites, and natural Broward County reefs
- Water quality should be relatively high with low rates of sedimentation and turbidity, and relatively minimal temperature fluctuations over daily, monthly or annual time frames
- Bottom types should be stable hardbottom or coral reefs within the nearshore ridge complex, Inner Reef, Middle Reef, or Outer Reef; areas with rubble should be avoided
- The size of each site should be able to accommodate ⅛ acre of reef enhancement
- Sites with existing organisms that compete for space, such as gorgonian canopy, encrusting sponges, *Palythoa*, and algae should be avoided
- Sites with existing high predator abundance, such as corallivorous snails, fireworms, and damselfish should be avoided if the predators cannot be effectively removed
- Wave exposure should be low to moderate in order to reduce physical disturbance to newly outplanted corals
- Corals should be placed where others currently exist or where they were historically present
- Sites should be in areas less subject to human activities that could damage corals

While actual site selection would occur during project ramp-up years and when project funds are appropriated, USACE and NMFS conclude there are a sufficient number of suitable sites for reef enhancement for the Port Everglades Navigation Study. This is based on their experiences working in Broward County waters and consultation with several experts. In addition, Broward County may ultimately prove to be one of the best places to achieve success with active propagation of *A. cervicornis* because there are presently very few large naturally occurring thickets of *Acropora cervicornis* anywhere in the Caribbean and the Keys other than in Broward County (pers com w/ USACE, R. Dodge, NSUOC, August 2013) and because *Acropora cervicornis* are naturally abundant in the area (pers com w/ USACE, B. Walker, NSUOC, August 2013).

6.5 Monitoring and Adaptive Management

6.5.1 Hardbottom Habitat Artificial Reef Mitigation

The monitoring program for the artificial reefs will include both physical and biological underwater assessment methods for five years. Physical monitoring will assess the degree of settling of reef materials, and annual biological monitoring will assess populations of algae, invertebrates, and fishes, and compare them to control sites on natural reefs.

The degree of settling and/or sand covering will be assessed by measuring the relief at each of the permanent quadrat stations established as outlined below. Measurements will be taken with a weighted flexible tape from a point one meter shoreward of the quadrat benchmark to the surface of the water and from the top of the reef structure at the benchmark to the surface of the water, with the difference being the relief. The mean of five such measurements will be used to assess the degree of settling and/or sand covering of the materials. Changes in relief at the control reef quadrat benchmarks will be assessed by the same method. If physical inspection reveals that the acreage or typical relief of the reef has been significantly reduced by subsidence, scour, or sand accretion, additional materials will be added as necessary to restore the reef to the as-built design.

A study design consisting of standard underwater assessment methods will be used in order to statistically compare mitigation reefs to natural reefs (control sites). Success criteria for benthic algae, invertebrates and fish populations will be established in order to demonstrate mitigation success. Success criteria will be based on the biological communities of control sites (natural reefs) and may include species richness, density, and cover of benthic algae, invertebrates, and fishes. Standard methods used to assess these parameters may include, but are not limited to in situ and/or video transect data collection for assessing benthic algae and invertebrate populations; in situ or photo-quadrat data collection for benthic algae and invertebrates; cylinder fish population surveys; and/or roving diver fish surveys. Appropriate parametric and/or non-parametric statistics shall be employed in order to demonstrate mitigation success criteria are met. *An example* of one possible biological sampling protocol is described below (specific methods will be developed during the PED phase of the project):

> Five randomly selected locations on each type of mitigation reef will be chosen and benchmarked for permanent photo-quadrat stations to assess sessile invertebrate and algae abundance. Randomly selected stations on high and low relief natural hardbottom reefs will also be established to serve as controls. Locations for ½-square-meter photo-quadrats will be established by driving two steel pins into the reef that will precisely locate the quadrat frame. The sites will be benchmarked using a DGPS system with sub-meter accuracy. Invertebrate and algal abundance will be evaluated from digital photography of each quadrat. Species will be identified to the lowest practical taxon and ranked in order of abundance. Superimposing a grid over the digital image and counting bare and colonized grid squares will assess overall percent cover (Bohnsack 1979). Criteria for success of the mitigation reef will be based upon a comparison of a total percent cover of algae and invertebrates at the new reefs and at control reefs of corresponding relief type. The criteria for success of the mitigation reefs in establishing a similar community structure will be a finding of no significant difference in the rank abundance orders of species between mitigation and control reefs of each type. Statistical comparisons between mitigation and control reefs will be made using the Wilcoxon Rank-Sum (Zar 1984) or similar nonparametric test at p=0.05.
>
> Fish population evaluations will be based on visual censuses conducted separately on HRHC and LRLC mitigation reefs and high and low relief control reefs. The point-count method (Bohnsack and Bannerot 1986) will be used for fish assessment. This method has the advantage of gathering quantitative data in a relatively short time in a very repeatable pattern that is relatively insensitive to differences in habitat structure. Each census will have a duration of five minutes and a radius (the distance from the stationary observer) of ten feet. Ten censuses will be collected on each of the four reef types. Data from these types of censuses is rarely normally distributed, so the Wilcoxon Rank-Sum or a similar nonparametric test will be used for significance testing. The criteria for mitigation reef success will be a finding of no significant difference at p=0.05 between reef type pairs (HRHC vs. high-relief control and LRLC vs. low-relief control).

Results of all mitigation reef monitoring efforts will be summarized in an annual report to be completed by December 31 of each year the monitoring program is in place (i.e., until success criteria are met). Copies of the report will be electronically available to all agencies and interested parties. Data from monitoring events will be reviewed by USACE staff in consultation with other federal and state agencies to guide decisions on necessary operational or structural changes (corrective actions) that may be needed to ensure that the mitigation project meets success criteria as defined above. Additional details regarding monitoring can be found in Appendix E-5.

6.5.2 Outplanted Nursery Corals

As part of the Monitoring and Adaptive Management Plan (Appendix E-6), the USACE contractor shall be required to monitor the outplanted corals propagated in the nursery for a three-year period for each outplanting area. After three years of monitoring that outplanting area, the final determination of success for that outplanting area will be made and if obtained, that area will no longer be monitored (Figure 9). If not, the area will be monitored until success is achieved. This may require corrective actions such as installation of additional colonies.

Year 1	Start up nursery					
Year 2	Outplant area 1					
Year 3	Monitor area 1	Outplant area 2				
Year 4	Monitor area 1	Monitor area 2	Outplant area 3			
Year 5	Monitor area 1	Monitor area 2	Monitor area 3	Outplant area 4		
Year 6		Monitor area 2	Monitor area 3	Monitor area 4	Outplant area 5	
Year 7			Monitor area 3	Monitor area 4	Monitor area 5	Outplant area 6
Year 8				Monitor area 4	Monitor area 5	Monitor area 6
Year 9					Monitor area 5	Monitor area 6
Year 10						Monitor area 6

Figure 9 Outplanting and Monitoring Scheme

6.6 Hardbottom Habitat Mitigation Success Criteria

The following success criteria for hardbottom mitigation sites is based on the most recent criteria developed and permitted for a deep-water mitigation site associated with a navigation project in South Florida:

1. The mitigation area and impact site must have biota with 75% species similarity by the time of the final, proposed (i.e., fifth year) monitoring event.

2. Percent-cover of major functional groups at the mitigation area will be similar to that of the impact site (80% similarity) by the time of the final, proposed (i.e., fifth-year) monitoring event.

6.7 Adaptive Management Plan for Hardbottom Habitat Mitigation

6.7.1 Artificial Reefs

If mitigation is not trending towards success by Year 3 following implementation of mitigation, corrective measures will be engaged. Among them, transplantation of additional corals from coral nurseries and deployment of additional reef material (associated costs are indicated in Table 15). Other options as deemed appropriate by USACE, in consultation with NMFS, FWS, FWC, FDEP, EPA and Broward County may also be carried out, depending on various site-specific factors.

Table 15 Mitigation Costs with Adaptive Management Added – Artificial Reefs

Coral/ Hardbottom mitigation	Construction Cost of Mitigation	Monitoring Costs	Total Costs
Artificial Reef/transplanted corals	$13,066,911	$508,000	$13,574,911

6.7.2 Outplanted Nursery Corals

Outplanted nursery corals shall be monitored for survival and corrective actions shall be taken, if necessary, to ensure survival remains above 80% (see Monitoring and Adaptive Management Plan found in Appendix E-6). Survival shall be compared to control sites with similar species composition as the outplant sites to detect any region-wide changes or stochastic events like disease or a hurricane. The project shall reflect similar coral survival as the control sites for the outplanted species. Control sites shall be selected by the contractor, reviewed by the USACE and the Adaptive Management Committee (see below) and approved by the Contracting Officer. Estimated costs for adaptive management actions regarding outplanted colonies are listed in Table 16.

Table 16 Mitigation Costs with Adaptive Management Added – Coral Propagation

Coral/ Hardbottom mitigation	Construction Cost of Mitigation	Monitoring and Adaptive Management Costs	Total Costs
Coral Propagation and outplanting	$10,680,290	$2,242,861^ ($640,817 monitoring, and $1,602,043 adaptive management)	$12,923,151

^ 6% monitoring and 15% adaptive management

Adaptive Management Committee. A committee consisting of USACE, NMFS, the implementing partner, and other applicable resource agencies will meet on a regular schedule, unless the committee determines only an "as-needed" basis is sufficient. The implementing partner will have the authority to make minor corrective actions under the contract. However, corrective actions that require major adaptive management action (e.g., site abandonment) will be reviewed by the committee and the committee will make a recommendation to USACE. USACE has the sole authority to require the implementing partner to undertake changes under the contract.

Minor and Major Corrective Actions. The Adaptive Management Committee will define what constitutes a minor versus a major corrective action and determine if the monitoring duration should be extended. Standard coral nursery and outplant adaptive management guidelines were provided by NMFS (see Appendix E-5) under their cooperating agency agreement under the National Environmental Policy Act. The NMFS guidelines will be incorporated into the contracting plans and specifications package for the coral propagation contract and may be modified in coordination with NMFS as new information from coral nurseries regarding nursery methods, outplant survival, and other factors become available between publication of the FEIS and publication of plans and specifications.

7.0 MITIGATION SUMMARY

Based on unavoidable impacts to significant resources due to the implementation of the Recommended Plan (i.e., the LPP), USACE and the local sponsor are proposing mitigation as detailed above, and as summarized in Table 17 below.

Table 17 Proposed Compensatory Mitigation by Habitat/Impact Type

Impact	Mitigation
Direct Impacts of Component 1, 10% of Component 3 & indirect effects to reefs/hardbottom	5 acres of artificial reef; outplanting of 103,191 propagated corals to enhancement sites
Seagrass Beds – Occupied Habitat	2.5 functional units debited from West Lake Park restoration/enhancement project
Mangrove Wetlands	1.0 functional units debited from West Lake Park restoration/enhancement project

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APPENDIX E-1

Uniform Mitigation Assessment Methodology Worksheets and Impact Site Plots for Seagrass and Mangrove Impact Areas

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SHD-00818**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.02** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SHD-00818**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
Current / With Impact	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
6 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators.**		
	c. Appropriateness of **soil moisture.**		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation.**		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
Current / With Impact	l. **Water depth, wave energy, and currents.**		
6 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
___x___ Vegetation	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
______ Benthic	VI. Plants' condition.		
	VII. Land management practices.		
______ Both	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current / With Impact	X. Upland assessment area		
3 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	With Impact
0.50	0.00

Impact Acres =	0.02

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.010

Impact Delta (ID)	
Current - w/Impact	0.50

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SHD-05641**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.13** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SHD-05641**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Indicator	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: **6** / **With Impact**: **0**	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators.**		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation.**		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents.**		
Current: **6** / **With Impact**: **0**	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure; _x_ Vegetation; __ Benthic; __ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: **3** / **With Impact**: **0**	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.50	0.00

Impact Acres =	0.13

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.065

Impact Delta (ID)	
Current - w/Impact	0.50

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SHJ-77084**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**1.77** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SHJ-77084**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
Current / With Impact	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
6 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
Current / With Impact	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
6 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
x Vegetation	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
___ Benthic	VI. Plants' condition.		
	VII. Land management practices.		
___ Both	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current / With Impact	X. Upland assessment area		
10 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.73	0.00

Impact Acres =	1.77

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	1.292

Impact Delta (ID)	
Current - w/Impact	0.73

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-01202**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.03** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-01202**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: 6 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
Current: 6 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure; x Vegetation; ___ Benthic; ___ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: 4 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criterie used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.53	0.00

Impact Acres =	0.03

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.016

Impact Delta (ID)	
Current - w/Impact	0.53

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-00515**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.01** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-00515**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: 6 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators.**		
	c. Appropriateness of **soil moisture.**		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation.**		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents.**		
Current: 6 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure — x Vegetation; ___ Benthic; ___ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: 4 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.53	0.00

Impact Acres =	0.01

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.005

Impact Delta (ID)	
Current - w/Impact	0.53

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-02944**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.07** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-02944**
Impact or Mitigation: **Impact**	Assessment Conducted by: **Dial Cordy and Associates Inc.**	Assessment Date: **See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Indicator	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
Current: 6 / With Impact: 0	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
Current: 6 / With Impact: 0	l. **Water depth, wave energy, and currents**.		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure; x Vegetation; ___ Benthic; ___ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current: 4 / With Impact: 0	X. Upland assessment area		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.53	0.00

Impact Acres =	0.07

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.037

Impact Delta (ID)	
Current - w/Impact	0.53

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-00900**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.02** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-00900**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: 6 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
Current: 6 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure; x Vegetation; ___ Benthic; ___ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: 4 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	With Impact
0.53	0.00

Impact Acres =	0.02

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.011

Impact Delta (ID)	
Current - w/Impact	0.53

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-02192**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.05** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SMX-02192**
Impact or Mitigation: **Impact**	Assessment Conducted by: **Dial Cordy and Associates Inc.**	Assessment Date: **See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
Current / With Impact	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
6 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
Current / With Impact	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
6 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
x Vegetation	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
___ Benthic	VI. Plants' condition.		
	VII. Land management practices.		
___ Both	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current / With Impact	X. Upland assessment area		
10 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	With Impact
0.73	0.00

Impact Acres =	0.05

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.037

Impact Delta (ID)	
Current - w/Impact	0.73

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHD-08612**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.20** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHD-08612**
Impact or Mitigation: **Impact**	Assessment Conducted by: **Dial Cordy and Associates Inc.**	Assessment Date: **See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(e) Location and Landscape Support	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
Current: 6 / With Impact: 0	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	a. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
Current: 6 / With Impact: 0	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure	I. Appropriate/desirable species		
x Vegetation	II. Invasive/exotic plant species		
___ Benthic	III. Regeneration/recruitment		
___ Both	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current: 2 / With Impact: 0	X. Upland assessment area		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	With Impact
0.47	0.00

Impact Acres =	0.20

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.094

Impact Delta (ID)	
Current - w/Impact	0.47

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHD-00416**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.01** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHD-00416**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
Current: 6 / With Impact: 0	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
Current: 6 / With Impact: 0	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
x Vegetation	III. Regeneration/recruitment		
	IV. Age, size distribution.		
Benthic	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
Both	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current: 1 / With Impact: 0	X. Upland assessment area		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.43	0.00

Impact Acres =	0.01

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.004

Impact Delta (ID)	
Current - w/Impact	0.43

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHJ-53469**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**1.23** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHJ-53469**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

.500(6)(a) Location and Landscape Support		Current	With Impact
	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: **6** / With Impact: **0**	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

.500(6)(b) Water Environment (n/a for uplands)		Current	With Impact
	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
Current: **6** / With Impact: **0**	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

.500(6)(c) Community Structure		Current	With Impact
x Vegetation	I. Appropriate/desirable species		
___ Benthic	II. Invasive/exotic plant species		
___ Both	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: **3** / With Impact: **0**	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.50	0.00

Impact Acres =	1.23

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.615

Impact Delta (ID)	
Current - w/Impact	0.50

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHJ-06911**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.16** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHJ-06911**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

		Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
Current: 6 / With Impact: 0	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
Current: 6 / With Impact: 0	l. **Water depth, wave energy, and currents**.		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
x Vegetation	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
____ Benthic	VI. Plants' condition.		
	VII. Land management practices.		
____ Both	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current: 4 / With Impact: 0	X. Upland assessment area		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.53	0.00

Impact Acres =	0.16

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.085

Impact Delta (ID)	
Current - w/Impact	0.53

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHJ-10206**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.23** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**WHJ-10206**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

		Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
Current / With Impact	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
6 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
Current / With Impact	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
6 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
x Vegetation	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
___ Benthic	VI. Plants' condition.		
	VII. Land management practices.		
___ Both	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current / With Impact	X. Upland assessment area		
4 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	With Impact
0.53	0.00

Impact Acres =	0.23

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.122

Impact Delta (ID)	
Current - w/Impact	0.53

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**MHD-00037**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.00** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**MHD-00037**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: 6 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
Current: 6 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure — x Vegetation; ___ Benthic; ___ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: 1 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)

Current	With Impact
0.43	0.00

Impact Acres =	0.00

Functional Loss (FL)
[For Impact Assessment Areas]:

FL = ID x Impact Acres =	0.000

Impact Delta (ID)

Current - w/impact	0.43

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**MHD-00039**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.00** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**MHD-00039**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: 6 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	a. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
Current: 6 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure — x Vegetation; ___ Benthic; ___ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: 1 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.43	0.00

Impact Acres =	0.00

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.000

Impact Delta (ID)	
Current - w/impact	0.43

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**IHD-03618**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.08** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Port Everglades Harbor/Intracoastal Waterway drains adjacent wetlands and flows to the Atlantic Ocean.

Assessment area description

Final EIS Figures 72 and 73 show the positions of seagrass assessment site numbers. Their positions can be located within Figures 49 and 50. Zones depicted therein are each described in Section 3.6.1.3.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet.	**Not rare in the Intracoastal Waterway, a man-made canal system.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Johnson's seagrass, manatees, and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

N/A

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.6.1.1 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**IHD-03618**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.6.1.1 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: 6 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators.**		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation.**		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
Current: 6 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure; x Vegetation; ___ Benthic; ___ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: 2 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.47	0.00

Impact Acres =	0.08

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.038

Impact Delta (ID)	
Current - w/Impact	0.47

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**OHD-08712**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
645	**Marine SAV**	**Impact**	**0.20** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
N/A	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

See Final EIS Figure 47. Port Everglades Harbor and the Intracoastal Waterway drain to the Atlantic Ocean through the inlet, in which this seagrass polygon lies.

Assessment area description

Seagrass spp observed within the study area included only *Halophila decipiens*. An estimated 1.03 acres of seagrass occurs between the nearshore hardbottom and middle reef in this area. An estimated 0.20 acre of this area lies within the project footprint.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Reefs, ocean inlet, Intracoastal Waterway	**SAV is rare offshore and on the channel bed.**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**N/A**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.6.1.2 "Seagrass biology and ecology."	**Manatees and sea turtles (see Final EIS Section 3.7.2).**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

None

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**August 28-30, 2013**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**OHD-08712**
Impact or Mitigation: **Impact**	Assessment Conducted by: **Dial Cordy and Associates Inc.**	Assessment Date: **August 28-30, 2013**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current 8 / **With Impact** 6	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation.**		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents.**		
Current 8 / **With Impact** 6	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure; x Vegetation; ____ Benthic; ____ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current 6 / **With Impact** 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.73	0.40

Impact Acres =	0.20

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.066

Impact Delta (ID)	
Current - w/Impact	0.33

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SWL-03677**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
612	**Mangrove swamp**	**Impact**	**0.08** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Mangroves are located in Port Everglades Harbor on Intracoastal Waterway, which drains adjacent wetlands and flows to the Atlantic Ocean. See Final EIS Figure 46, Zone #2, and small area northeast of Zone #1 (north of turning notch, west side of ICW) for affected areas.

Assessment area description

Assessment zones depicted in Figure 46 are each described in Section 3.5.2. Final EIS Figures 72 and 73 (Section 4.3.3) show the positions of wetland impact site/polygon numbers within Zone #2 and the small impact site on the west side of ICW.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet and John U. Lloyd Beach State Park	**Not rare**
Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.5.2 "Wetlands (Mangroves)."	**Yes; Florida DER permit 060924019, USACE 84Y.4146**
Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.5.2 "Wetlands (Mangroves)."	**N/A**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

None.

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.5.2 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SWL-03677**
Impact or Mitigation: **Impact**	Assessment Conducted by: **Dial Cordy and Associates Inc.**	Assessment Date: **See Section 3.5.2 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
Current: 6 / With Impact: 0	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation.**		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
Current: 7 / With Impact: 0	l. **Water depth, wave energy, and currents.**		
	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure _x_ Vegetation ___ Benthic ___ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: 5 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.60	0.00

Impact Acres =	0.08

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.048

Impact Delta (ID)	
Current - w/Impact	0.60

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functionel Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name **Navigation Improvements, Port Everglades**	Application Number **Not Yet Determined**	Assessment Area Name or Number **SWL-03093, -03918, & -09492**

FLUCCs code **612**	Further classification (optional) **Mangrove swamp**	Impact or Mitigation Site? **Impact**	Assessment Area Size **0.379** Acres

Basin/Watershed Name/Number **S. Florida Coastal**	Affected Waterbody (Class) **III**	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance) **N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Mangroves are located in Port Everglades Harbor on Intracoastal Waterway, which drains adjacent wetlands and flows to the Atlantic Ocean. See Final EIS Figure 46, Zone #2, and small area northeast of Zone #1 (north of turning notch, west side of ICW) for affected areas.

Assessment area description

Assessment zones depicted in Figure 46 are each described in Section 3.5.2. Final EIS Figures 72 and 73 (Section 4.3.3) show the positions of wetland impact site/polygon numbers within Zone #2 and the small impact site on the west side of ICW.

Significant nearby features **Ocean inlet and John U. Lloyd Beach State Park**	Uniqueness (considering the relative rarity in relation to the regional landscape.) **Not rare**
Functions **See Final EIS Section 3.5.2 "Wetlands (Mangroves)."**	Mitigation for previous permit/other historic use **Yes for SWL-09492 only; Florida DER permit 060924019, USACE 84Y.4146**
Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found) **See Final EIS Section 3.5.2 "Wetlands (Mangroves)."**	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area) **N/A**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

None.

Additional relevant factors:

N/A

Assessment conducted by: **Dial Cordy and Associates Inc.**	Assessment date(s): **See Section 3.5.2 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SWL-03093, -03918, & -09492**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.5.2 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity **of habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: 8 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
Current: 8 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure — x Vegetation; ____ Benthic; ____ Both	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
	VI. Plants' condition.		
	VII. Land management practices.		
	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
	X. Upland assessment area		
Current: 9 / **With Impact**: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.83	0.00

Impact Acres =	0.38

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.315

Impact Delta (ID)	
Current - w/impact	0.83

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SWL-00144 & -09620**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
612	**Mangrove swamp**	**Impact**	**0.224** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Mangroves are located in Port Everglades Harbor on Intracoastal Waterway, which drains adjacent wetlands and flows to the Atlantic Ocean. See Final EIS Figure 46, Zone #2, and small area northeast of Zone #1 (north of turning notch, west side of ICW) for affected areas.

Assessment area description

Assessment zones depicted in Figure 46 are each described in Section 3.5.2. Final EIS Figures 72 and 73 (Section 4.3.3) show the positions of wetland impact site/polygon numbers within Zone #2 and the small impact site on the west side of ICW.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet and John U. Lloyd Beach State Park	**Not rare**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.5.2 "Wetlands (Mangroves)."	**Yes; Florida DER permit 060924019, USACE 84Y.4146**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.5.2 "Wetlands (Mangroves)."	**N/A**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

None.

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Dial Cordy and Associates Inc.	**See Section 3.5.2 of the Final EIS**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SWL-00144 & -09620**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Impact	**Dial Cordy and Associates Inc.**	**See Section 3.5.2 of the Final EIS**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Criteria	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
Current / With Impact	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
Current: 6 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
Current / With Impact	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
Current: 7 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
x Vegetation	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
____ Benthic	VI. Plants' condition.		
	VII. Land management practices.		
____ Both	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current / With Impact	X. Upland assessment area		
Current: 9 / With Impact: 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	With Impact
0.73	0.00

Impact Acres =	0.22

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.161

Impact Delta (ID)	
Current - w/impact	0.73

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SWL-00386**

FLUCCs code	Further classification (optional)	Impact or Mitigation Site?	Assessment Area Size
612	**Mangrove swamp**	**Impact**	**0.009** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
S. Florida Coastal	**III**	**N/A**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

Mangroves are located in Port Everglades Harbor on Intracoastal Waterway, which drains adjacent wetlands and flows to the Atlantic Ocean. See Final EIS Figure 46, Zone #2, and small area northeast of Zone #1 (north of turning notch, west side of ICW) for affected areas.

Assessment area description

Assessment zones depicted in Figure 46 are each described in Section 3.5.2. Final EIS Figures 72 and 73 (Section 4.3.3) show the positions of wetland impact site/polygon numbers within Zone #2 and the small impact site on the west side of ICW.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
Ocean inlet and John U. Lloyd Beach State Park	**Not rare**

Functions	Mitigation for previous permit/other historic use
See Final EIS Section 3.5.2 "Wetlands (Mangroves)."	**Yes; Florida DER permit 060924019, USACE 84Y.4146**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
See Final EIS Section 3.5.2 "Wetlands (Mangroves)."	**N/A**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

None.

Additional relevant factors:

N/A

Assessment conducted by:	Assessment date(s):
Based on nearest evaluated Coastal Systems International (2008) ***Assessment of Mangrove Wetland Function and Value, Port***	**See CSI (2008) letter-report**

Form 62-345.900(1), F.A.C. [effective date]

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UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - IMPACT
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Navigation Improvements, Port Everglades	**Not Yet Determined**	**SWL-00386**
Impact or Mitigation: **Impact**	Assessment Conducted by: **Based on nearest evaluated Coastal Systems International (2008) Assessment of Mangrove**	Assessment Date: **See CSI (2008) letter-report**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Section	Indicator	Current	With Impact
.500(6)(a) Location and Landscape Support	a. Quality and quantity of **habitat support** outside of AA.		
	b. **Invasive plant species.**		
	c. **Wildlife access** to and from AA (proximity and barriers).		
	d. **Downstream benefits** provided to fish and wildlife.		
	e. Adverse impacts to wildlife in AA from **land uses** outside of AA.		
	f. **Hydrologic connectivity** (impediments and flow restrictions).		
	g. **Dependency** of downstream habitats on quantity or quality of discharges.		
Current / **With Impact**	h. Protection of wetland functions provided by uplands (**upland** AAs only).		
8 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(b) Water Environment (n/a for uplands)	a. Appropriateness of **water levels and flows**.		
	b. Reliability of **water level indicators**.		
	c. Appropriateness of **soil moisture**.		
	d. **Flow rates**/points of discharge.		
	e. **Fire frequency**/severity.		
	f. **Type of vegetation**.		
	g. **Hydrologic stress** on vegetation.		
	h. **Use by animals** with hydrologic requirements.		
	i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).		
	j. **Water quality of standing water by observation** (i.e., discoloration, turbidity).		
Current / **With Impact**	k. **Water quality data** for the type of community.		
	l. **Water depth, wave energy, and currents**.		
8 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	
.500(6)(c) Community Structure	I. Appropriate/desirable species		
	II. Invasive/exotic plant species		
	III. Regeneration/recruitment		
x Vegetation	IV. Age, size distribution.		
	V. Snags, dens, cavity, etc.		
Benthic	VI. Plants' condition.		
	VII. Land management practices.		
Both	VIII. Topographic features (refugia, channels, hummocks).		
	IX. Submerged vegetation (only score if present).		
Current / **With Impact**	X. Upland assessment area		
8 / 0	Notes: Enter notes here	Place an "X" in the box above next to the two (2) most important criteria used in scoring this section	

Raw Score = Sum of above scores/30 (if uplands, divide by 20)	
Current	**With Impact**
0.80	0.00

Impact Acres =	0.01

Functional Loss (FL) [For Impact Assessment Areas]:	
FL = ID x Impact Acres =	0.008

Impact Delta (ID)	
Current - w/Impact	0.80

NOTE: If impact is proposed to be mitigated at a mitigation bank that was assessed using UMAM, then the credits required for mitigation is equal to Functional Loss (FL). If impact mitigation is proposed at a mitigation bank that was not assessed using UMAM, then UMAM cannot be used to assess impacts; use the assessment method of the mitigaiton bank.

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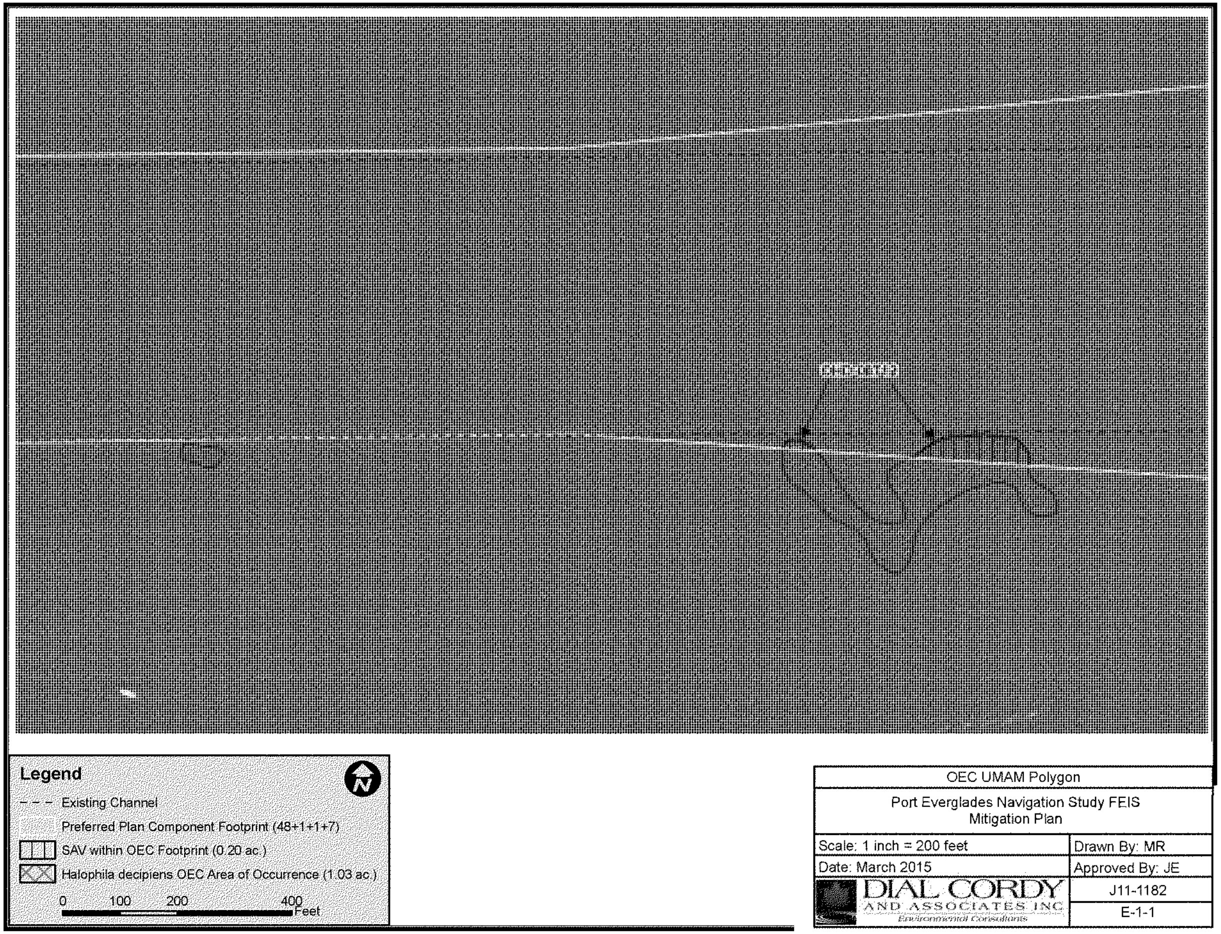
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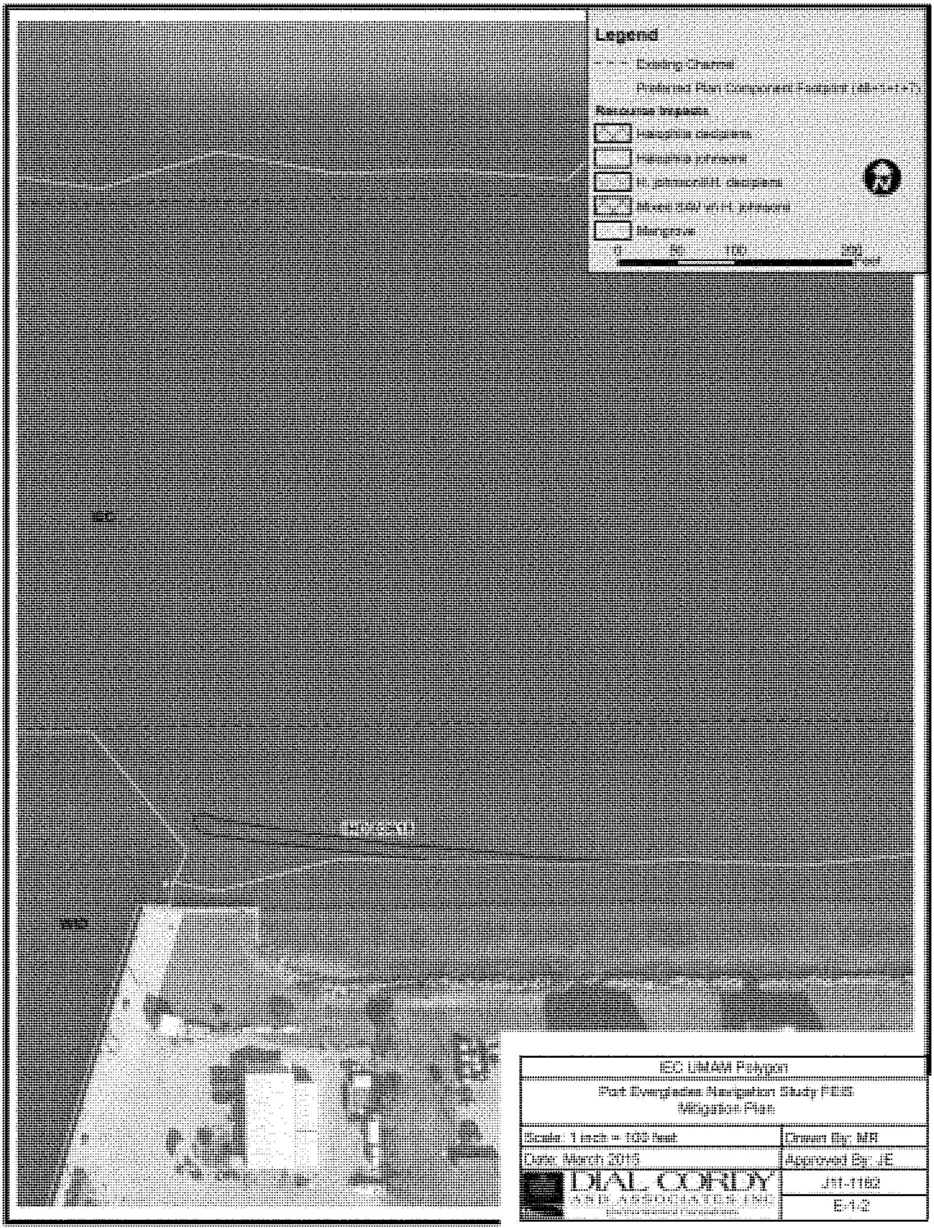
Preferred Plan Component Footprint (48+1+1+7)
SAV within OEC Footprint (0.20 ac.)
Halophila decipiens OEC Area of Occurrence (1.03 ac.)
0 100 200 400 Feet
OEC UMAM Polygon
Port Everglades Navigation Study FEIS
Mitigation Plan
Scale: 1 inch = 200 feet
Drawn By: MR
Date: March 2015
Approved By: JE
DIAL CORDY AND ASSOCIATES INC
Environmental Consultants
J11-1182
E-1-1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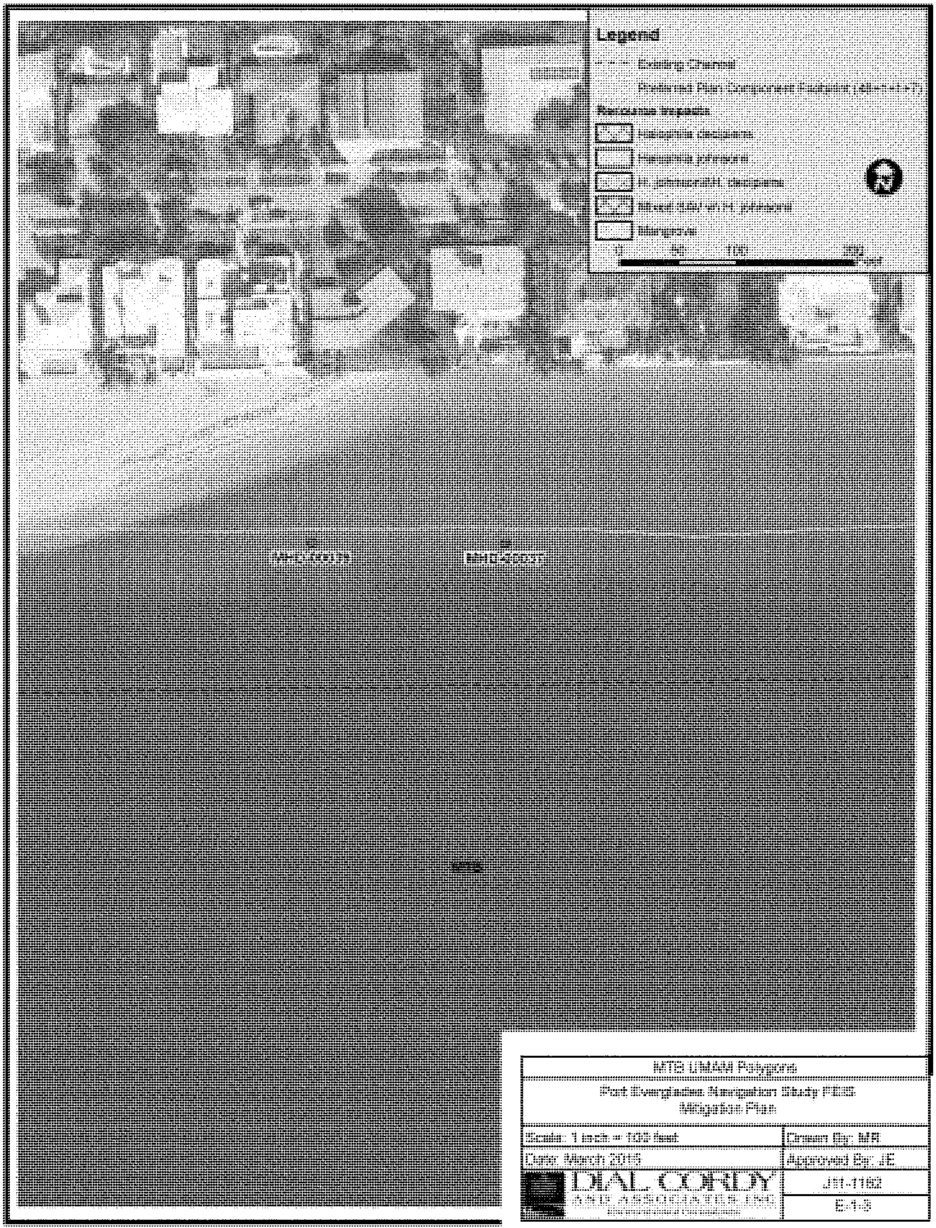
Existing Channel
Preferred Plan Component Footprint
Resource Impacts
Halophila decipiens
Halophila johnsonii
Mangrove
ISC UMAM Polygon
Port Everglades Navigation Study FEIS
Mitigation Plan
Scale: 1 inch = 100 feet
Drawn By: MR
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC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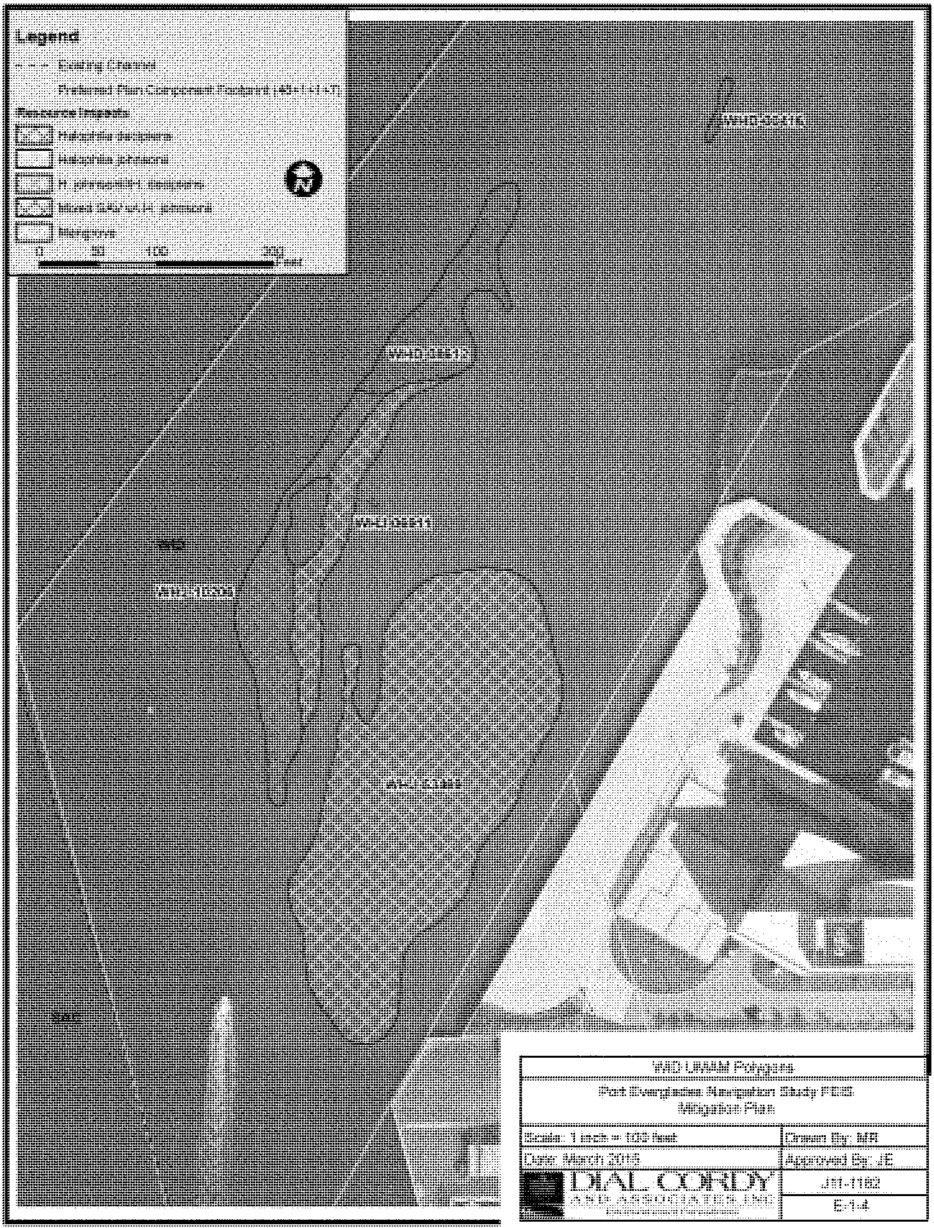
Preferred Plan Component Footprint
Resource Impacts
Mangrove
MTB
MTB UMAM Polygons
Port Everglades Navigation Study FEIS
Mitigation Plan
Scale: 1 inch = 100 feet
Drawn By: MR
Date: March 2015
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC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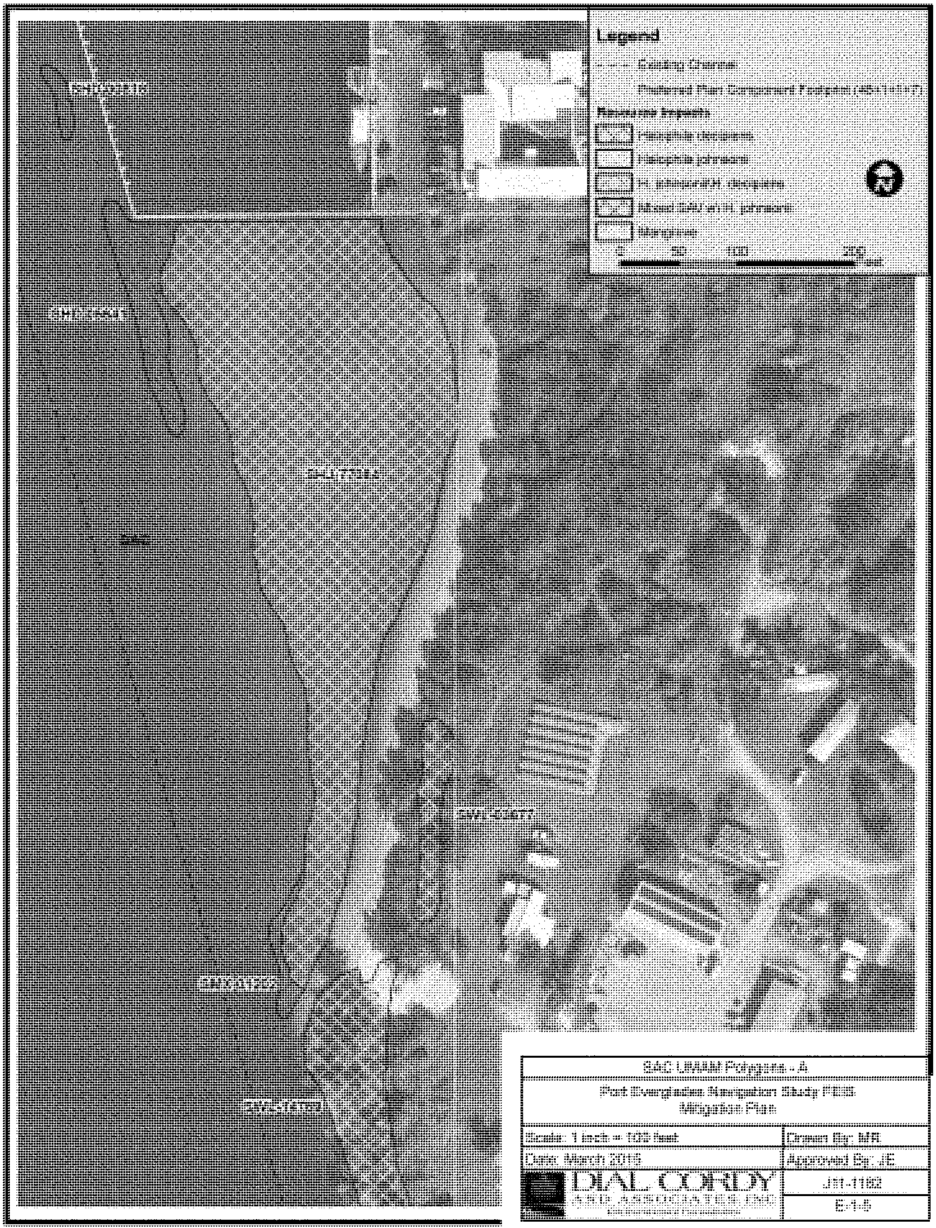
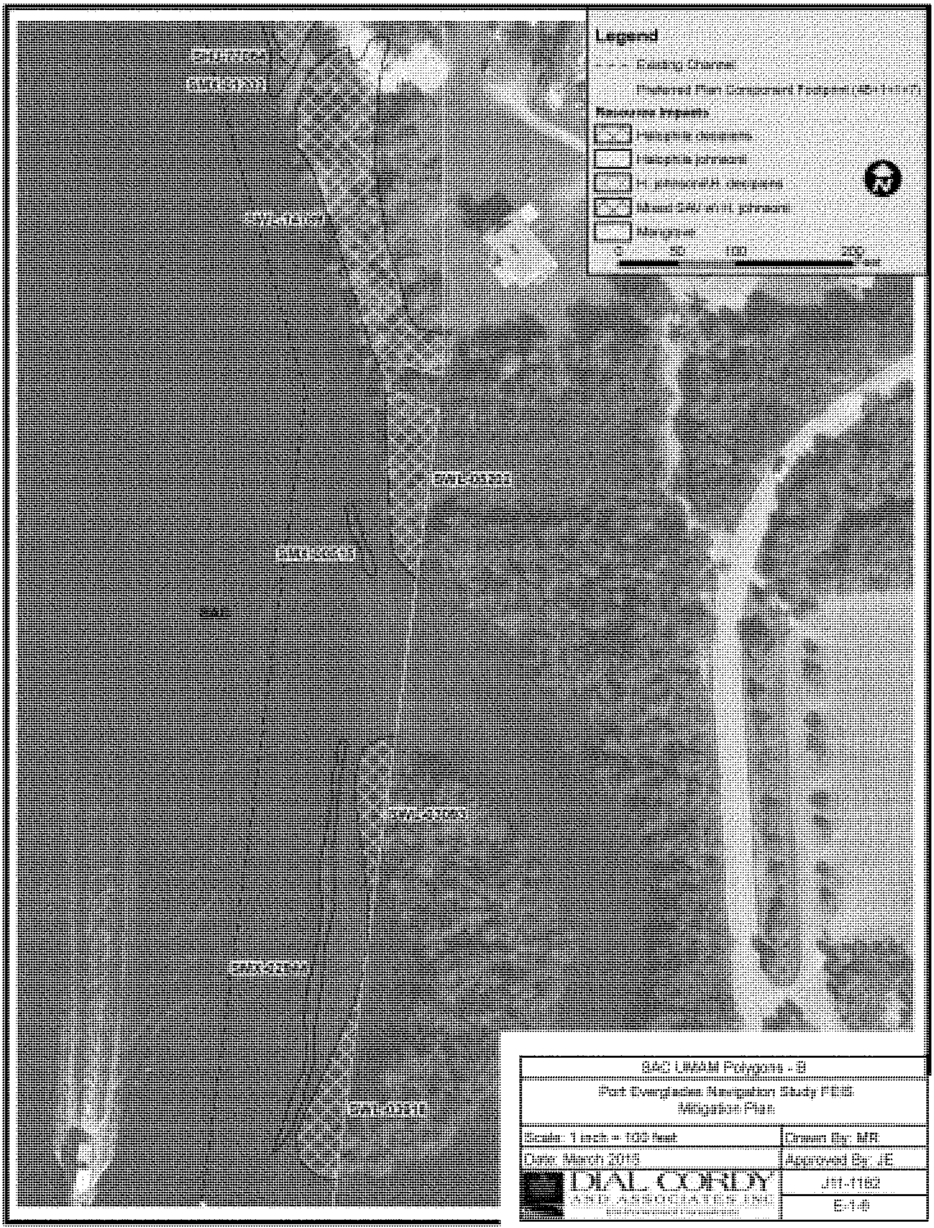
Mangrove
Mitigation Plan
Scale: 1 inch = 100 feet
Drawn By: MR
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC
E-1-4


Legend
Existing Channel
Halophila decipiens
Halophila johnsonii
H. johnsonii/H. decipiens
Mixed SAV w/ H. johnsonii
SAC UMAM Polygons - A
Port Everglades Navigation Study FEIS
Mitigation Plan
Scale: 1 inch = 100 feet
Drawn By: MR
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC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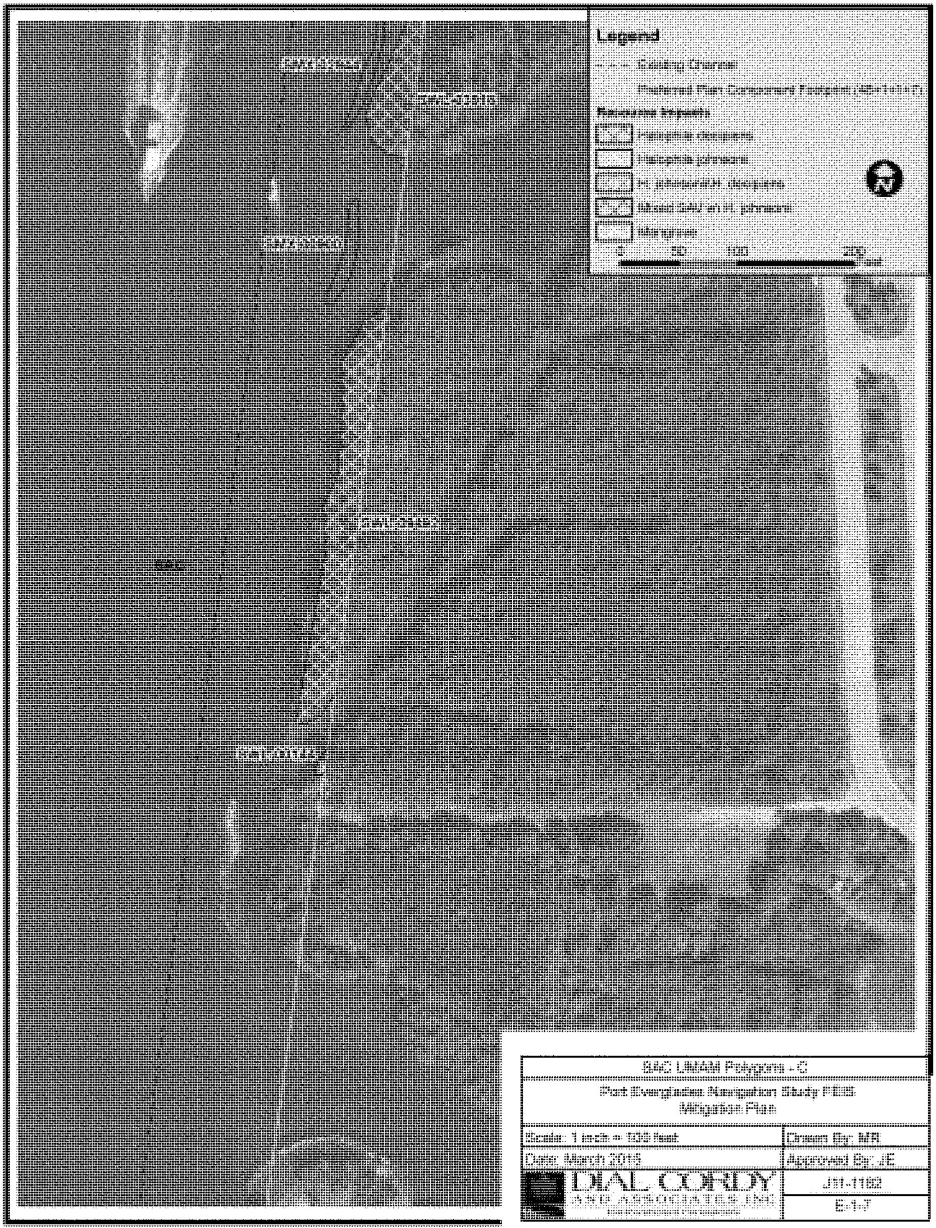
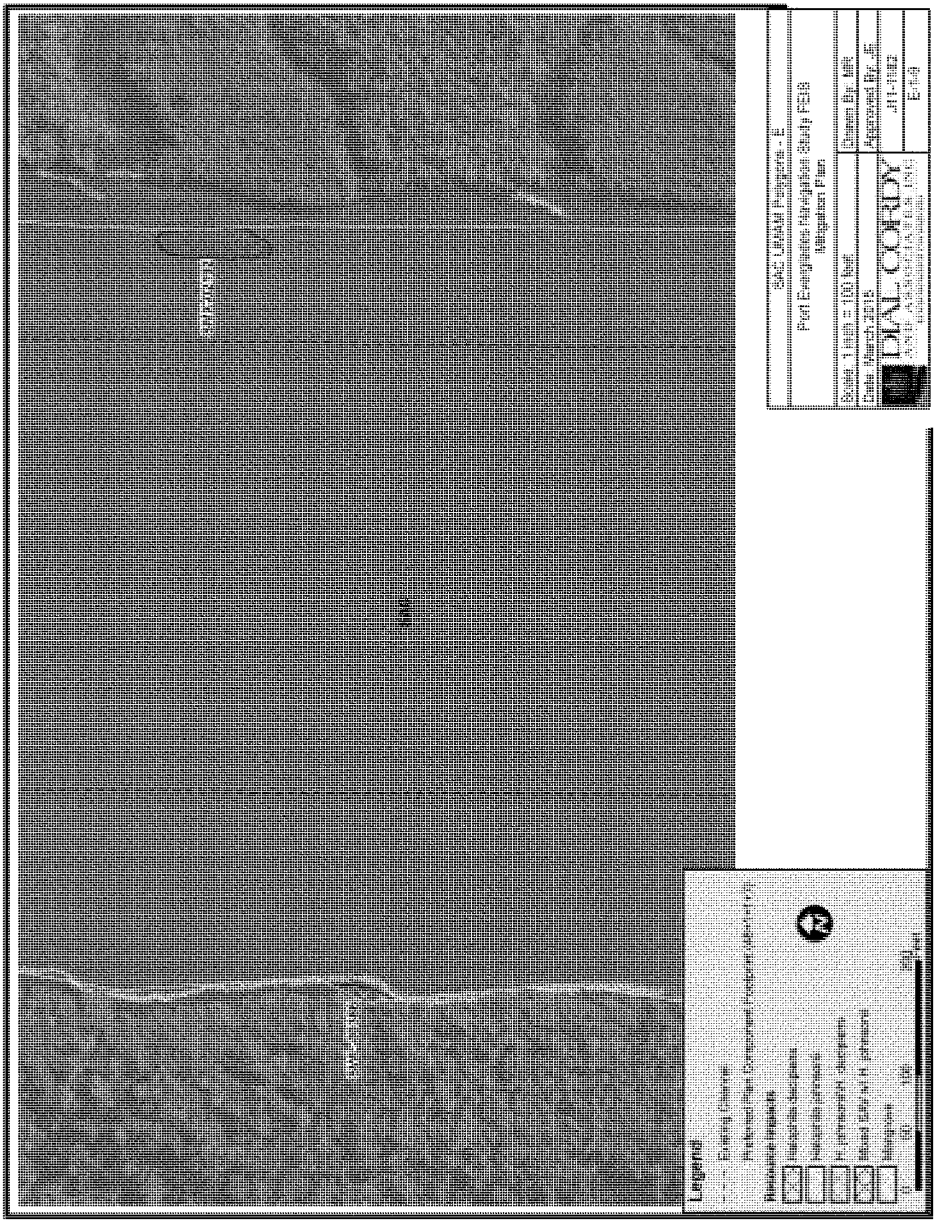
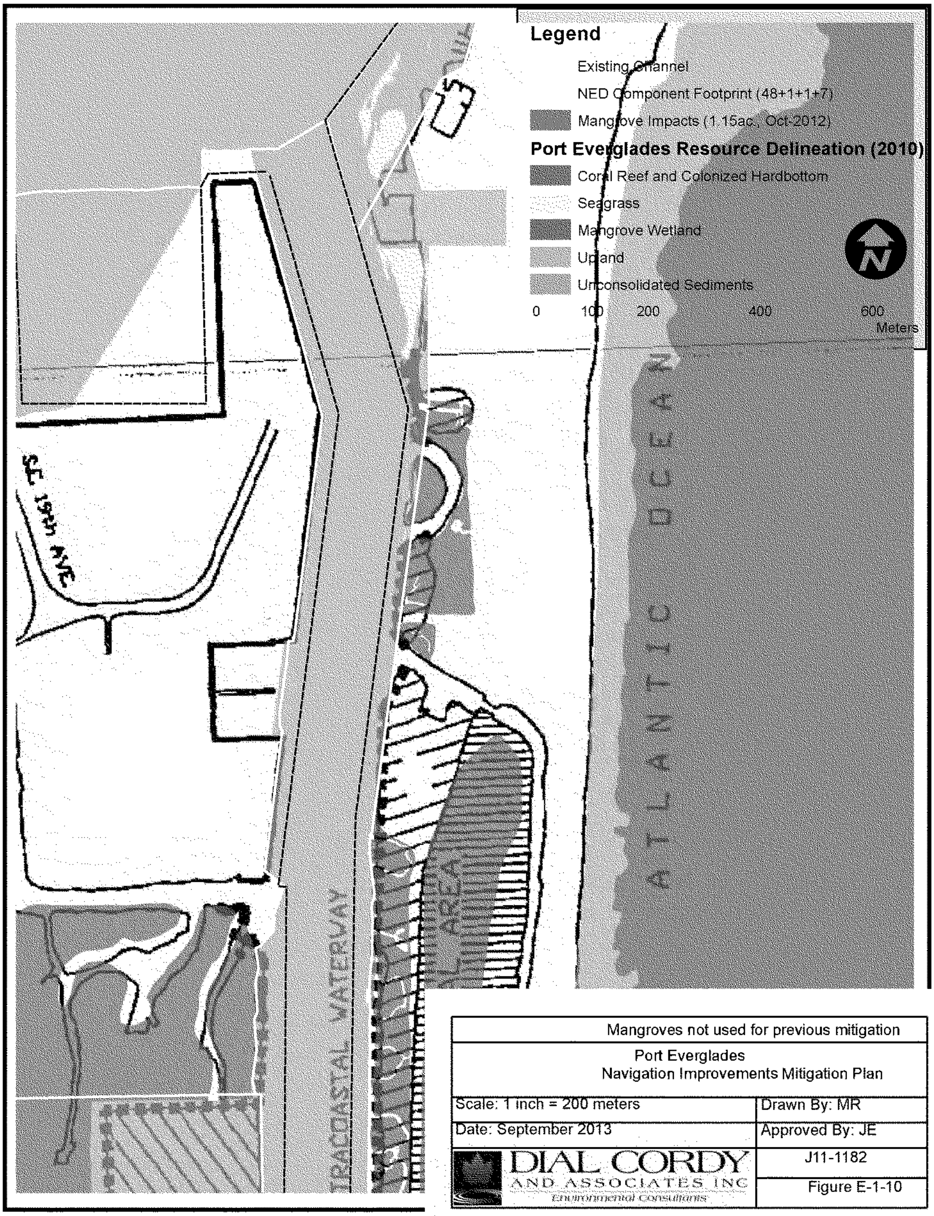
Port Everglades Navigation Study FEIS
Mitigation Plan
Scale: 1 inch = 100 feet
Drawn By: MR
Approved By: JE
DIAL CORDY


Legend
Existing Channel
Resource Impacts
Halophila decipiens
Halophila johnsonii
H. johnsonii/H. decipiens
Mixed SAV w/ H. johnsonii
Mangrove
SAC UMAM Polygons - C
Port Everglades Navigation Study FEIS
Mitigation Plan
Scale: 1 inch = 100 feet
Drawn By: MR
Date: March 2015
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC
E-1-7


Legend
0
50
100
200
Port Everglades Navigation Study FEIS
Mitigation Plan
Scale: 1 inch = 100 feet
Drawn By: MR
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC
E-1-6


DIAL CORDY
Legend



Mangroves not used for previous mitigation

Port Everglades
Navigation Improvements Mitigation Plan

Scale: 1 inch = 200 meters	Drawn By: MR
Date: September 2013	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure E-1-10

Identification of 1990 wetland mitigation areas (coarse-hatched areas) based on Grading, Ditch Installation and Rip-Rap Placement Drawing, JUL State Recreation Area, for Port Everglades Authority by Lewis Environmental Services, Tampa, FL, Drawing 83SA 3330, 31 August 1989

APPENDIX E-2

Environmental Permits for West Lake Park Improvements

Update

Update

Number: ______________________

DEPARTMENT OF THE ARMY PERMIT

DUPLICATE

Permittee: Broward County Parks and Recreation Division
Attn: Pat Young
Administrative Manager
950 N.W. 38th Street
Oakland Park, FL 33309

Permit No: SAJ-2002-00072(IP-LAO)

Issuing Office: U.S. Army Engineer District, Jacksonville

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: To provide up-front compensation to be used for wetland impacts associated with future Broward County projects, the County has proposed a mitigation plan for upland, wetland, and seagrass creation, restoration, enhancement and preservation of mangroves and seagrasses within West Lake Park in Broward County.

The project is to install culvert connections to increase flushing of a 1500+ acre mangrove forest, tidal flushing channels, construct a riprap/crib structure for shoreline stabilization along approximately 3 miles of shoreline adjacent to the mangrove edge along the ICW and for approximately 1.5 miles along the Dania Cutoff canal. The riprap/crib structure shall be created using piling supports on one or both sides of the riprap with pilings parallel to the shoreline with horizontal reinforcing bars to create the support structure for the riprap. A geotube base filled with clean fill will be laid within the crib structure for stabilization. Where the structure is adjacent to resources, as shown in the attached drawings, riprap placement will be within a 5-foot wide crib structure which is vertical on both sides with pilings and stringers. Where the riprap will not be placed adjacent to resources, the piling support structure will be only built on the landward edge of the mangrove fringe and the riprap will be placed against and waterward of it with the waterward slope of the riprap being no steeper than 1.5 horizontal to 1 vertical.

The project will also include the scrape down and/or removal of exotic vegetation from approximately 63 acres of upland soil to create mangrove, mudflat, tidal flats and pools, seagrass, and maritime hammock habitat. Additionally, exotic vegetation removal will occur in smaller areas throughout the park. A temporary expansion of an existing road involving 0.03 acres of impacts will be installed to allow spoil removal.

The project is proposed to create ±24.2 acres of mangrove habitat, 7.0 acres of mud flats/tidal pools, 8.6 acres of tidal channels, 8.0 acres of seagrass habitat, 13.4 acres of maritime hammock, 1.9 acres of structural habitat in the form of a riprap crib structure along the ICWW, and 2.0 acres of supplemental structural habitat (riprap) along the Dania Cut-off Canal. Project restoration would consist of 1.5 acres of mud flats/tide pools, and improving 3.5 acres of flushing channels within the Dania Salt Marsh, and removing derelict barges which currently shade 0.5 acres of potential seagrass habitat within Whiskey Creek. Project enhancement/creation consists of 32 acres of mangroves, removal of 8.4 acres of exotic vegetation and replanting of sea oxeye daisy, and removing and preventing future exotic infestations in 10 acres. Project preservation consists of 23.3 acres of outparcel acquisition, and 30 acres of seagrass/manatee protection areas.

The work described above is to be completed in accordance with the 33 pages of drawings and 8 attachments affixed at the end of this permit instrument, specifically Attachment 4 which outlines the projects construction methodology, monitoring requirements, and timing.

Project Location: The project is located in West Lake Park, a county park composed almost entirely of a mangrove forest west of the Intracoastal Waterway and south of the Dania Cutoff Canal, Dania Beach (Sections 1, 2 and 11, Township 50 south, Range 42 east, Broward County, Florida.

Directions to site: From I-95 in Fort Lauderdale, exit east at Sheridan Street and go east 2.6 miles. The project is on both sides of Sheridan Street.

Latitude & Longitude: Latitude: 26° 2′ 20″ North
Longitude: 80° 7′ 10″ West

Permit Conditions

General Conditions:

1. The time limit for completing the work authorized ends on **February 28, 2011**. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and State coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature and the mailing address of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

1. Submittals required herein shall be directed to:

Department of the Army
Jacksonville District Corps of Engineers
Regulatory Division, Enforcement Section
P.O. Box 4970
Jacksonville, Florida 32232-0019

A courtesy copy of any required enhancement/creation reports will also be provided to:

U.S. Army Corps of Engineers
South Permits Branch Office
4400 PGA Boulevard, Suite 500
Palm Beach Gardens, FL 33410

2. Prior to commencement of construction in or adjacent to wetlands and/or Waters of the United States, the perimeter of the enhancement/creation construction area(s) shall be enclosed with staked and trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas.

3. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date.

4. The permittee shall conduct a pre-construction meeting prior to commencement of construction in order to notify in-house staff, field crews, contractors, subcontractors, and all persons involved in the construction of West Lake Park Enhancement/creation Project of the conditions of this permit. The permittee shall educate and inform staff members and contractors of these procedures. Copies of the permit and specific conditions shall be displayed at the construction site.

5. All storage or stockpiling of tools or materials (i.e. lumber, pilings, etc.) shall be limited to uplands or within the impact areas authorized by this project.

6. All temporary wetland impacts associated with the enhancement/creation construction activities shall be restored to preexisting wetland conditions immediately following completion of the construction element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time-zero enhancement/creation monitoring report and shall

be maintained and monitored in conjunction with the enhancement/creation monitoring program provided for in the enclosed exhibits.

7. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the Corps may require the permittee to provide appropriate enhancement/creation to the Corps. The Corps may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

8. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or Waters of the United States prior to disposal in a suitable upland spoil disposal area or placement in the geotube base for the riprap crib.

9. The permittee shall comply with the attached Manatee Construction Conditions enclosed in attachment #3 which are also outlined in this condition. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

The permittee shall advise all construction personnel that there are civil penalties and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water wherever possible.

If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee(s). these precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida.
Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 8 ½ by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida.

10. The permittee shall install and maintain permanent manatee awareness signs/education displays.

11. As provided in Attachment 4, Broward County Parks and Recreation Division shall be responsible for the enhancement/creation construction, five year maintenance and monitoring and perpetual management of the proposed enhancement/creation efforts at West Lake Park.

12. A maintenance program shall be implemented in accordance with Attachment 5 for the enhancement/creation areas on a regular basis to ensure the integrity and viability of those areas as permitted. Maintenance shall be conducted in perpetuity to ensure that the enhancement/creation areas are maintained free from Category 1 exotic vegetation (as defined by the Florida Exotic Pest Plant Council at the time of permit issuance) immediately following a maintenance activity. Coverage of exotic and nuisance

plant species shall not exceed 5% of total cover between maintenance activities. In addition, the permittee shall manage the conservation areas such that exotic/nuisance plant species do not dominate any one section of those areas.

13. A time zero monitoring report for the West Lake Park enhancement/creation project shall be conducted in accordance with Attachment 5 for all completed enhancement/creation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

14. The permittee shall submit annual monitoring reports to the Corps for a period of five years, the first not later than one year after the submission of the time-zero report. Each monitoring report shall provide a narrative, professional biological opinion of the condition of the enhancement/creation improvements. The monitoring report shall also contain a plan view describing the vegetative community, the percent cover for each community, a list of species and their percent cover for each community, the percent cover of wetland and of exotic plant species, the sum of the survivors of those planted plus those recruited, a description of any unusual climatic or other factors, and photos from the same point as where the photos for the time-zero report.

15. Perpetual maintenance of the enhancement/creation areas shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

16. Generally, the enhancement/creation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater, and/or estuarine wetland communities. The use of mitigation units from this project shall be limited to projects undertaken by or for Broward County. The Corps will determine if the use of mitigation credits from this project is warranted and appropriate for use as mitigation on other projects. The suitability of this enhancement/creation area

to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

17. The amount of potential credit generated by the enhancement/creation efforts must be confirmed through post-project monitoring to reveal if actual habitat creation and enhancement/creation occurs. These ecological benefits were estimated using the Uniform Mitigation Assessment Method (UMAM) and are summarized in Attachment 6. The values are presumed correct, but are adjustable by the Corps if adequate lift has not been achieved or if proposed acreages for mitigation areas are not enhanced/created as proposed. Verification methods to determine actual acreages for Improvement and verification of potential credits generated from this creation/enhancement project are shown in Attachment 7. Use of such enhancement/creation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the enhancement/creation credit. Any habitat restoration/enhancement/creation that occurs as a result of this project does not preclude the need to fully adhere to the federal sequential enhancement/creation requirements on future regulated activities.

18. Management items identified in Attachment 8 and described in Attachment 4 may be later considered for enhancement/creation credit through a modification of this permit if supporting information to justify enhancement/creation credit for items has been sufficiently demonstrated to the Corps.

19. No modifications to this permit shall be required for construction methodology variations from those described in Attachment 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that Corps staff concurs with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by Corps regulatory or compliance staff.

20. Select mangrove trimming necessary to accomplish the planned enhancement/creation efforts described herein shall be authorized by this permit.

21. Since the installation of the buoys for the 'boating exclusion zone" is located within the Federal right-of-way for the Federal Channel, **a Department of the Army Consent to Easement is also required *prior* to commencement of installation of the**

buoys. By copy of this letter, the permit is being forwarded to the Corps Real Estate Division for action on the Consent.

22. Enhancement/creation credit for the designated manatee/seagrass protection areas shall be granted only after documentation of a Consent to Easement for installation of the manatee protection barriers from the U.S. Army Corps of Engineers Real Estate Division has been submitted to the offices as outlined in Special Condition #21.

23. The Permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structures or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the Permittee will be required, upon due notice from the U.S. Army Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

24. Fill material used with this project (temporary road expansion and geotube creation) shall be limited to suitable, clean fill material, which excludes materials such as trash, debris, car bodies, asphalt, construction materials, concrete block with exposed reinforcement bars, and any soils contaminated with any toxic substance in toxic amounts (see Section 307 of the Clean Water Act).

25. Following completion of the crib installation, the permittee shall complete a post-installation seagrass survey from the riprap crib structure waterward for a distance 50 feet. This post construction seagrass survey will be conducted in the growing season (April 1-August 31) following the crib construction and shall be submitted to Corps no later than October 1 that year. The seagrass survey shall be compared with the 2002 seagrass survey done by Miller Legg and Associates, Inc. If the post construction seagrass survey shows that seagrasses have been impacted or are no longer growing in their previous locations (adjacent to the crib structure), a UMAM analysis on the seagrass habitats affected based on the Corps earlier UMAM analysis of the West Lake Seagrass areas should be conducted by the permittee and submitted to the Corps for approval. The UMAM debits from the areas affected shall be deducted from any actual seagrass creation/enhancement credits earned through this overall

project. If sufficient actual mitigation credits are not available to offset the impacts caused to seagrasses by the crib structure, the Corps will require remedial measures and will require additional mitigation as necessary to fully offset impacts resulting from the installation of the crib structure.

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

( ) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, State, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal projects.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision: This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (see 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions: General Condition 1 establishes a time limit for the completion of the activity authorized by this permit.

Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

Pat Young — 2/28/06

(PERMITTEE) (DATE)

PAT YOUNG

(PERMITTEE NAME-PRINTED)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

3-2-2006

(DISTRICT ENGINEER) (DATE)
Robert M. Carpenter
Colonel, U.S. Army

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

______________________________ ________________
(TRANSFEREE-SIGNATURE) (DATE)

____
(NAME-PRINTED)

____
(ADDRESS)

____
(CITY, STATE, AND ZIP CODE)

Attachments to Department of the Army Permit Number SAJ-2002-00072(IP-LAO)

1. PERMIT DRAWINGS: Thirty-three (33) pages, dated February 17, 2006.

2. WATER QUALITY CERTIFICATION: Specific Conditions of the water quality permit/certification in accordance with General Condition number 5 on page 2 of this DA permit. Six (6) pages.

3. Standard Manatee Construction Conditions dated July 2005.

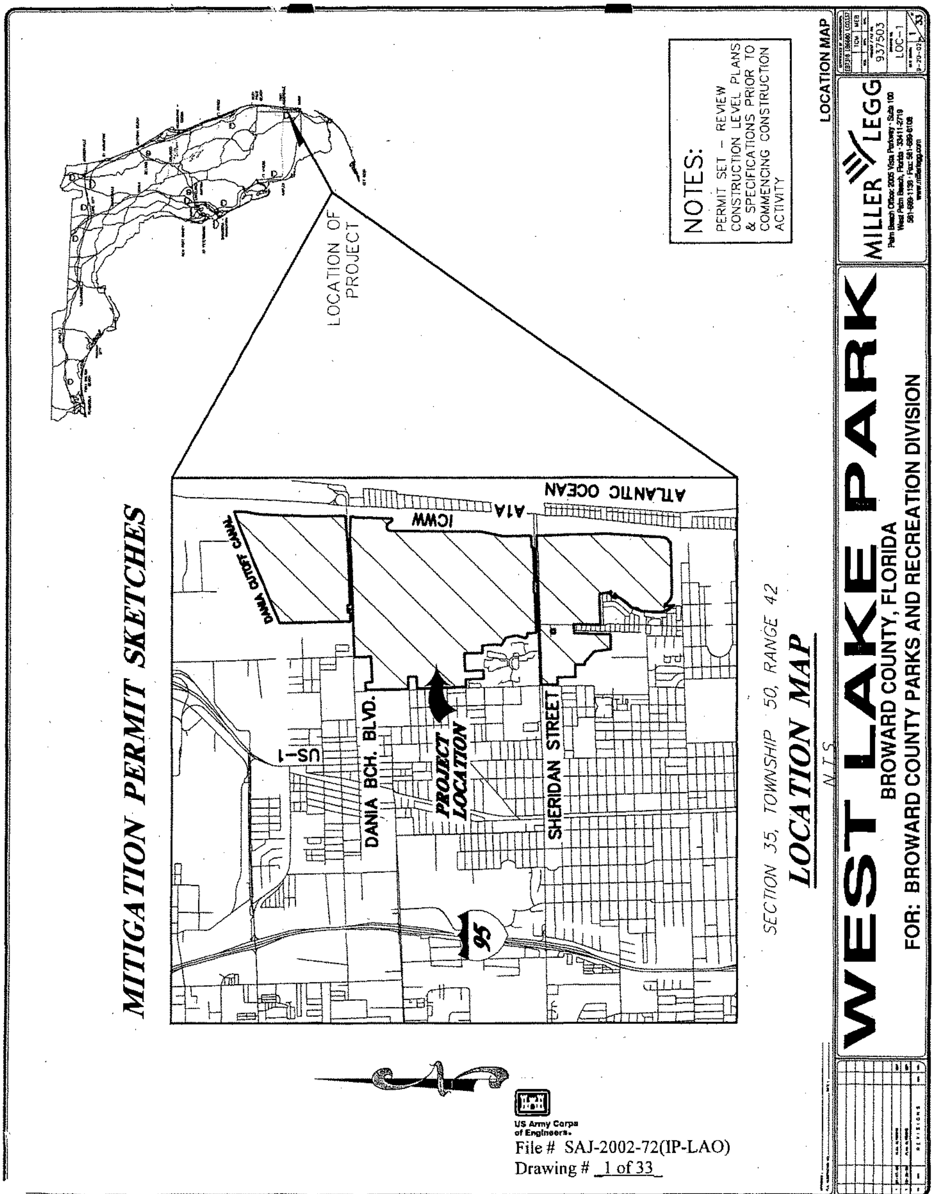
4. Letter of responsibility from Broward County dated May 28, 2002.

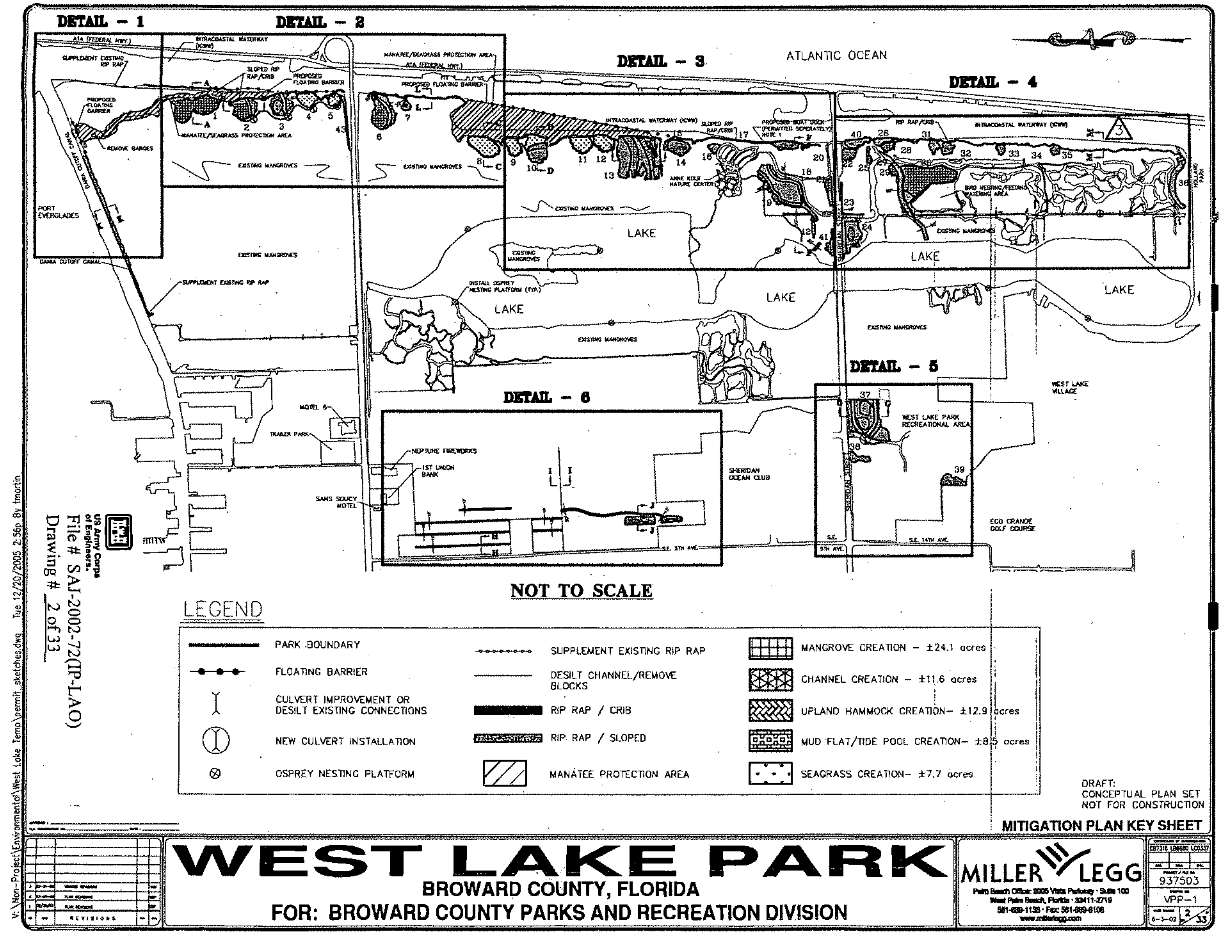
5. West Lake Park Mitigation Plan dated November 25, 2003. Thirty-eight (38) pages.

6. West Lake Mitigation - US Corps of Engineers Estimated Mitigation Credit Chart.

7. West Lake Mitigation - Methods to Determine Acreages for Improvements.

8. West Lake Mitigation - West Lake Mitigation Unit (Acreage) Estimates


MITIGATION PERMIT SKETCHES
LOCATION OF PROJECT
NOTES:
PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
ATLANTIC OCEAN
A1A
ICWW
DANIA CUTOFF CANAL
DANIA BCH. BLVD.
US-1
PROJECT LOCATION
SHERIDAN STREET
95
SECTION 35, TOWNSHIP 50, RANGE 42
LOCATION MAP
N.T.S.
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
LOCATION MAP
937503
LOC-1
33
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 1 of 33


DETAIL - 1
DETAIL - 2
DETAIL - 3
DETAIL - 4
DETAIL - 5
DETAIL - 6
ATLANTIC OCEAN
LAKE
PORT EVERGLADES
DANIA CUTOFF CANAL
SUPPLEMENT EXISTING RIP RAP
EXISTING MANGROVES
INSTALL OSPREY NESTING PLATFORM (TYP.)
ANNE KOLB NATURE CENTER
BIRD NESTING/FEEDING WATERING AREA
WEST LAKE PARK RECREATIONAL AREA
WEST LAKE VILLAGE
SHERIDAN OCEAN CLUB
ECO GRANDE GOLF COURSE
NEPTUNE FIREWORKS
1ST UNION BANK
SANS SOUCY MOTEL
MOTEL 6
TRAILER PARK
HOLLAND PARK
NOT TO SCALE
LEGEND
PARK BOUNDARY
FLOATING BARRIER
CULVERT IMPROVEMENT OR DESILT EXISTING CONNECTIONS
NEW CULVERT INSTALLATION
OSPREY NESTING PLATFORM
SUPPLEMENT EXISTING RIP RAP
DESILT CHANNEL/REMOVE BLOCKS
RIP RAP / CRIB
RIP RAP / SLOPED
MANATEE PROTECTION AREA
MANGROVE CREATION - ±24.1 acres
CHANNEL CREATION - ±11.6 acres
UPLAND HAMMOCK CREATION- ±12.9 acres
MUD FLAT/TIDE POOL CREATION- ±8.5 acres
SEAGRASS CREATION- ±7.7 acres
DRAFT:
CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION
MITIGATION PLAN KEY SHEET
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
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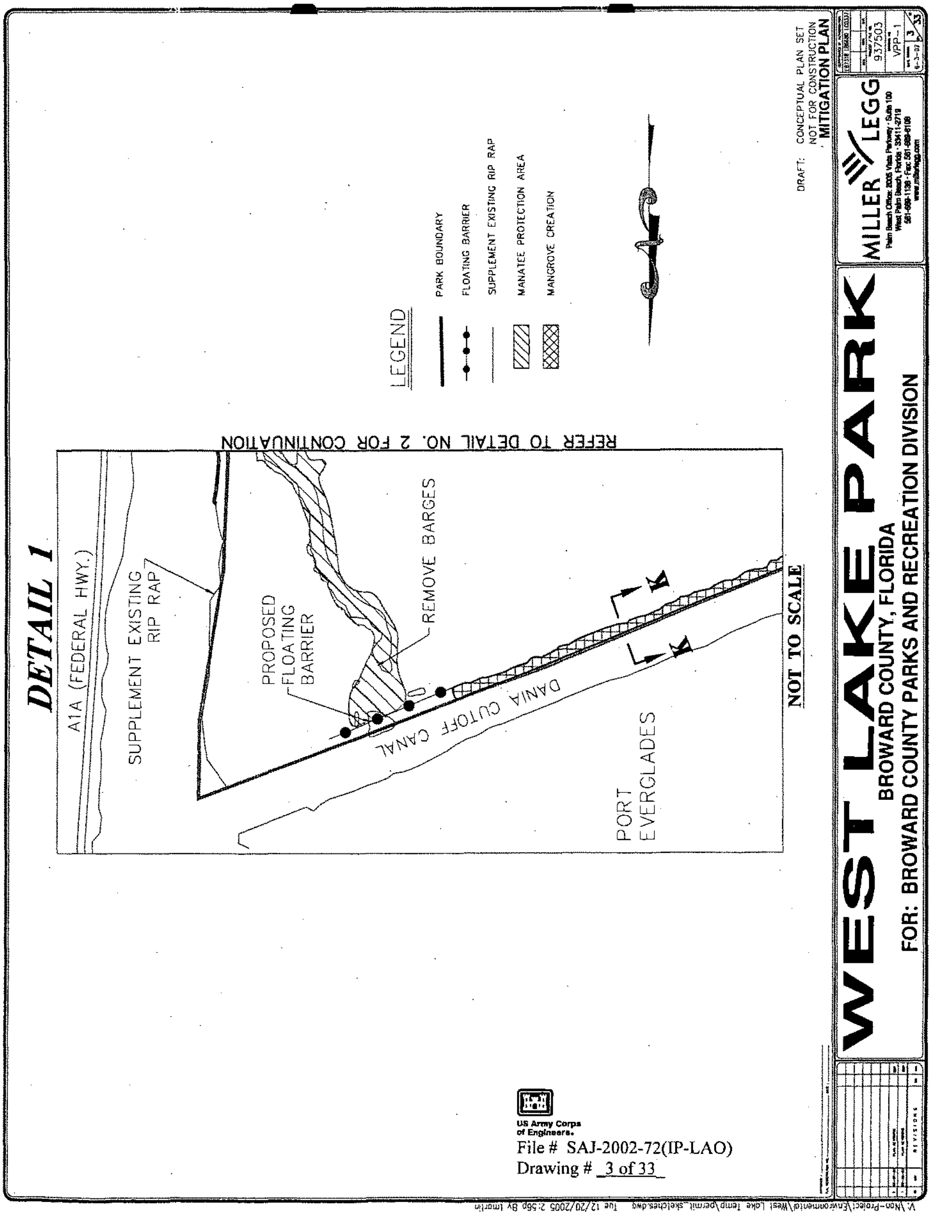
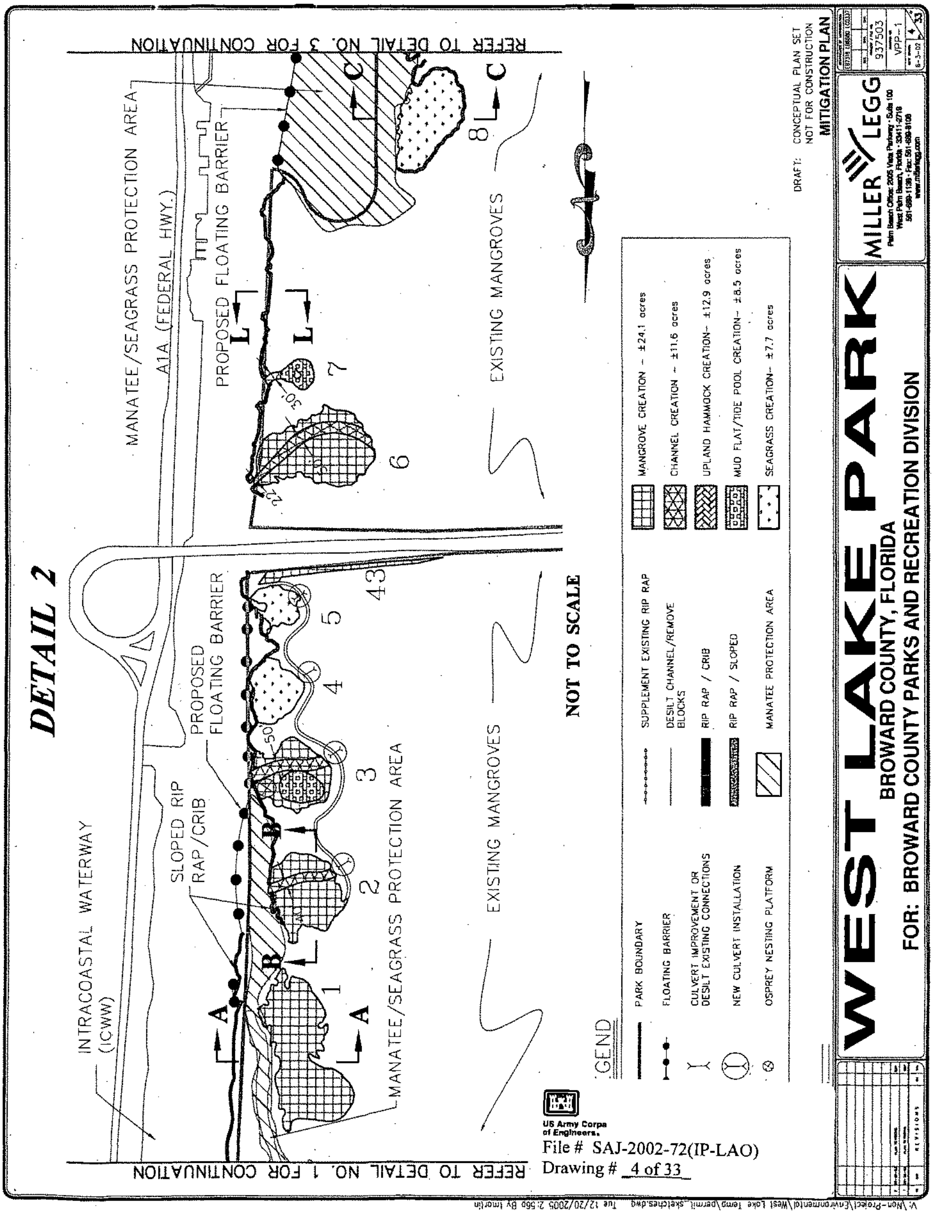
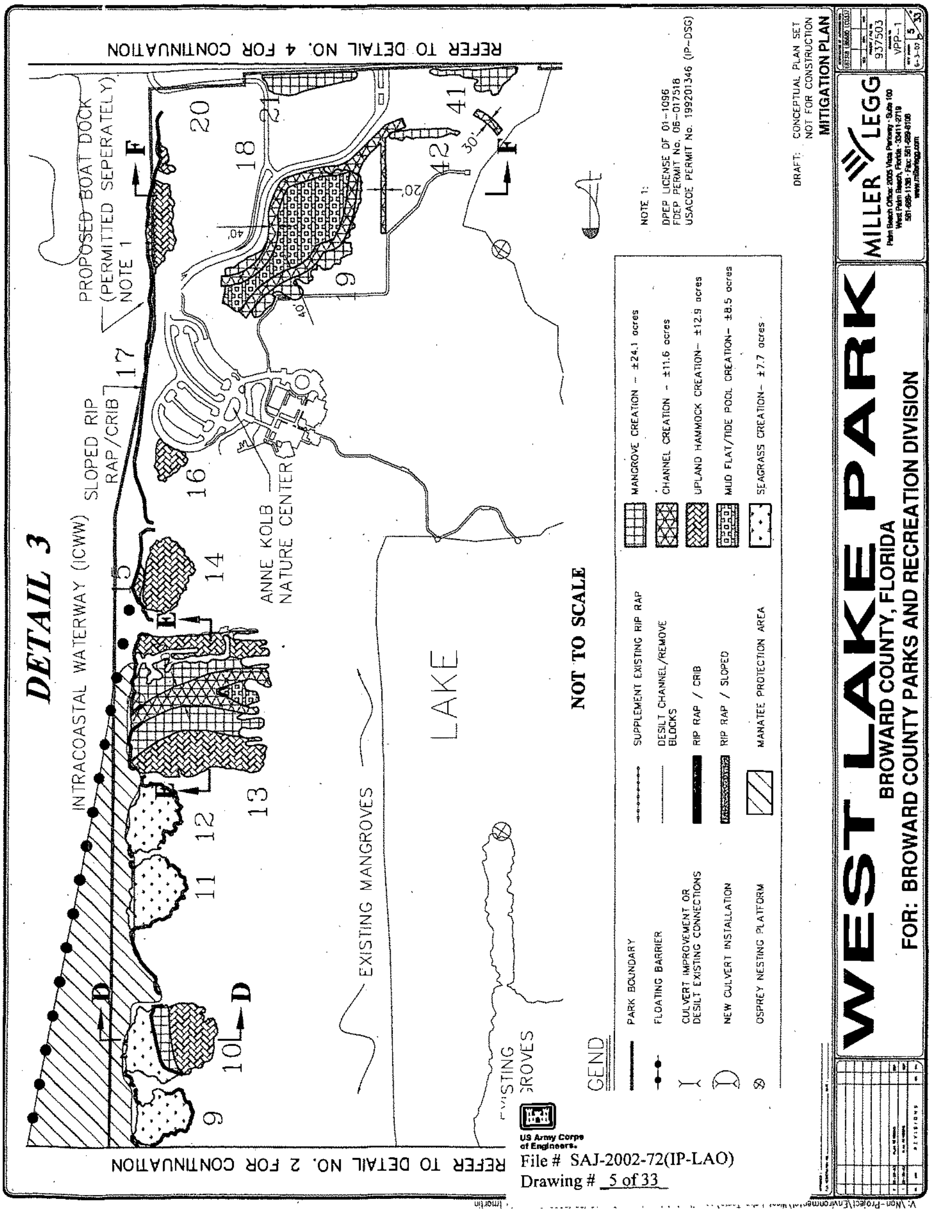
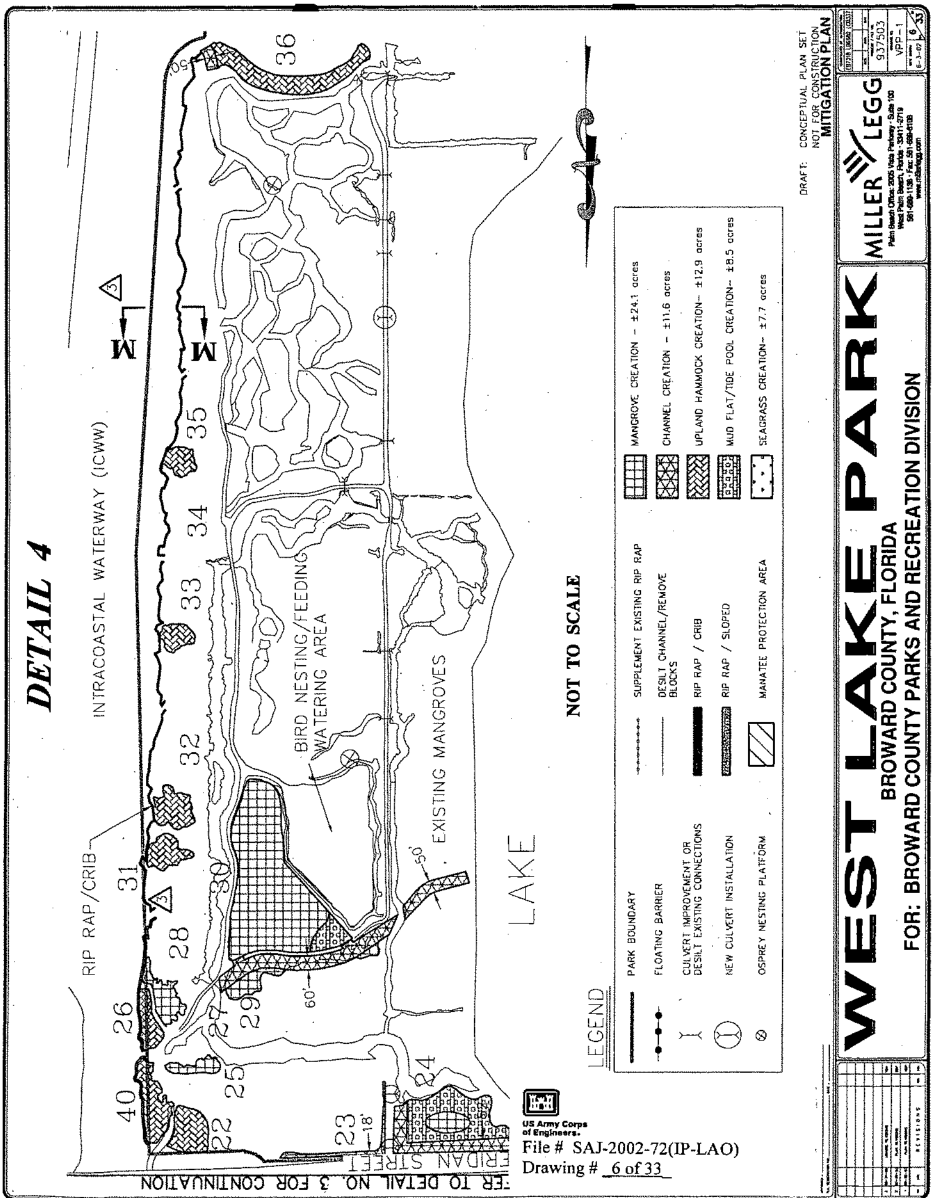
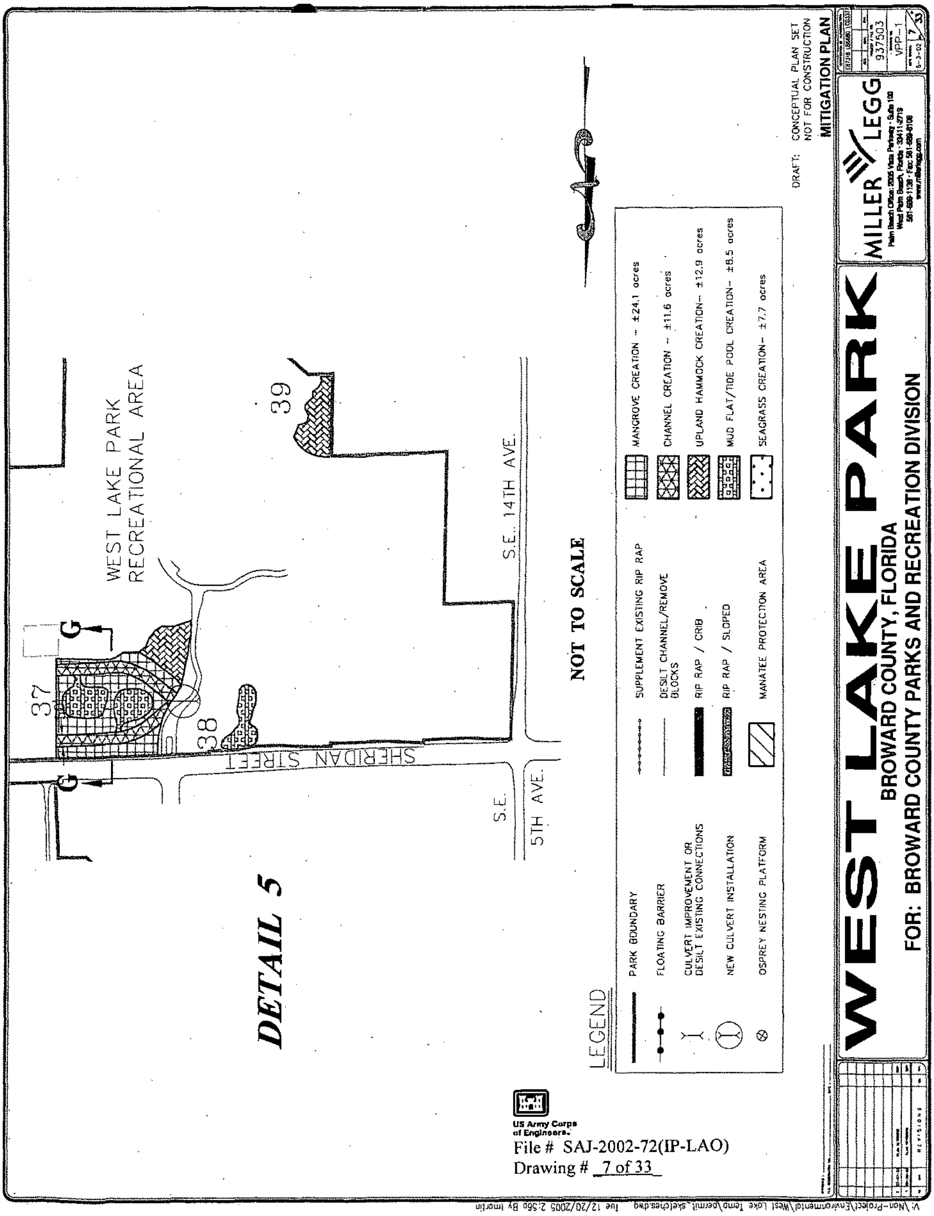
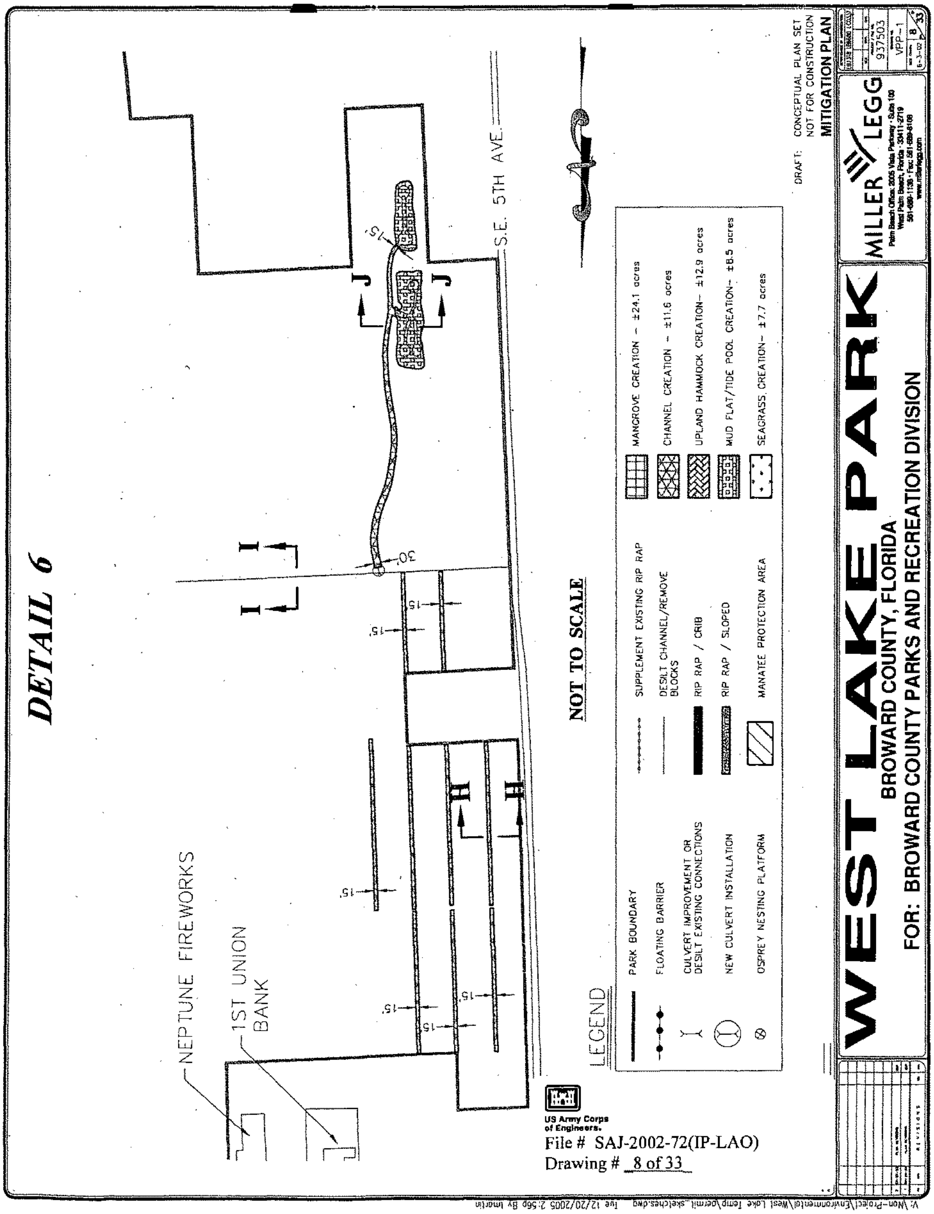

DETAIL 1
A1A (FEDERAL HWY.)
SUPPLEMENT EXISTING RIP RAP
PROPOSED FLOATING BARRIER
REMOVE BARGES
REFER TO DETAIL NO. 2 FOR CONTINUATION
DANIA CUTOFF CANAL
PORT EVERGLADES
NOT TO SCALE
LEGEND
PARK BOUNDARY
FLOATING BARRIER
SUPPLEMENT EXISTING RIP RAP
MANATEE PROTECTION AREA
MANGROVE CREATION
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MITIGATION PLAN
MILLER LEGG
937503
VPP-1
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 3 of 33


DETAIL 2
REFER TO DETAIL NO. 1 FOR CONTINUATION
REFER TO DETAIL NO. 3 FOR CONTINUATION
INTRACOASTAL WATERWAY (ICWW)
SLOPED RIP RAP/CRIB
PROPOSED FLOATING BARRIER
MANATEE/SEAGRASS PROTECTION AREA
A1A (FEDERAL HWY.)
EXISTING MANGROVES
NOT TO SCALE
LEGEND
PARK BOUNDARY
FLOATING BARRIER
CULVERT IMPROVEMENT OR DESILT EXISTING CONNECTIONS
NEW CULVERT INSTALLATION
OSPREY NESTING PLATFORM
SUPPLEMENT EXISTING RIP RAP
DESILT CHANNEL/REMOVE BLOCKS
RIP RAP / CRIB
RIP RAP / SLOPED
MANATEE PROTECTION AREA
MANGROVE CREATION – ±24.1 acres
CHANNEL CREATION – ±11.6 acres
UPLAND HAMMOCK CREATION– ±12.9 acres
MUD FLAT/TIDE POOL CREATION– ±8.5 acres
SEAGRASS CREATION– ±7.7 acres
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MITIGATION PLAN
MILLER LEGG
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 4 of 33
937503
VPP-1
V:\Non-Project\Environmental\West Lake Temp\permit_sketches.dwg Tue 12/20/2005 2:56p By lmartin


DETAIL 3
INTRACOASTAL WATERWAY (ICWW)
SLOPED RIP RAP/CRIB
PROPOSED BOAT DOCK (PERMITTED SEPERATELY) NOTE 1
REFER TO DETAIL NO. 2 FOR CONTINUATION
REFER TO DETAIL NO. 4 FOR CONTINUATION
ANNE KOLB NATURE CENTER
EXISTING MANGROVES
LAKE
NOT TO SCALE
GEND
PARK BOUNDARY
FLOATING BARRIER
CULVERT IMPROVEMENT OR DESILT EXISTING CONNECTIONS
NEW CULVERT INSTALLATION
OSPREY NESTING PLATFORM
SUPPLEMENT EXISTING RIP RAP
DESILT CHANNEL/REMOVE BLOCKS
RIP RAP / CRIB
RIP RAP / SLOPED
MANATEE PROTECTION AREA
MANGROVE CREATION - ±24.1 acres
CHANNEL CREATION - ±11.6 acres
UPLAND HAMMOCK CREATION- ±12.9 acres
MUD FLAT/TIDE POOL CREATION- ±8.5 acres
SEAGRASS CREATION- ±7.7 acres
NOTE 1:
DPEP LICENSE DF 01-1096
FDEP PERMIT No. 06-017518
USACOE PERMIT No. 199201346 (IP-DSG)
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MITIGATION PLAN
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 5 of 33


DETAIL 4
INTRACOASTAL WATERWAY (ICWW)
RIP RAP/CRIB
BIRD NESTING/FEEDING WATERING AREA
EXISTING MANGROVES
LAKE
NOT TO SCALE
LEGEND
PARK BOUNDARY
FLOATING BARRIER
CULVERT IMPROVEMENT OR DESILT EXISTING CONNECTIONS
NEW CULVERT INSTALLATION
OSPREY NESTING PLATFORM
SUPPLEMENT EXISTING RIP RAP
DESILT CHANNEL/REMOVE BLOCKS
RIP RAP / CRIB
RIP RAP / SLOPED
MANATEE PROTECTION AREA
MANGROVE CREATION - ±24.1 acres
CHANNEL CREATION - ±11.6 acres
UPLAND HAMMOCK CREATION- ±12.9 acres
MUD FLAT/TIDE POOL CREATION- ±8.5 acres
SEAGRASS CREATION- ±7.7 acres
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MITIGATION PLAN
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
6 of 33
US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 6 of 33
ER TO DETAIL NO. 3 FOR CONTINUATION
RIDAN STREET


WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MITIGATION PLAN
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MILLER LEGG
937503
VPP-1
7
33
DETAIL 5
NOT TO SCALE
WEST LAKE PARK RECREATIONAL AREA
SHERIDAN STREET
S.E. 14TH AVE.
S.E. 5TH AVE.
37
38
39
G
LEGEND
PARK BOUNDARY
FLOATING BARRIER
CULVERT IMPROVEMENT OR DESILT EXISTING CONNECTIONS
NEW CULVERT INSTALLATION
OSPREY NESTING PLATFORM
SUPPLEMENT EXISTING RIP RAP
DESILT CHANNEL/REMOVE BLOCKS
RIP RAP / CRIB
RIP RAP / SLOPED
MANATEE PROTECTION AREA
MANGROVE CREATION – ±24.1 acres
CHANNEL CREATION – ±11.6 acres
UPLAND HAMMOCK CREATION– ±12.9 acres
MUD FLAT/TIDE POOL CREATION– ±8.5 acres
SEAGRASS CREATION– ±7.7 acres
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 7 of 33


DETAIL 6
NEPTUNE FIREWORKS
1ST UNION BANK
S.E. 5TH AVE.
NOT TO SCALE
LEGEND
PARK BOUNDARY
FLOATING BARRIER
CULVERT IMPROVEMENT OR DESILT EXISTING CONNECTIONS
NEW CULVERT INSTALLATION
OSPREY NESTING PLATFORM
SUPPLEMENT EXISTING RIP RAP
DESILT CHANNEL/REMOVE BLOCKS
RIP RAP / CRIB
RIP RAP / SLOPED
MANATEE PROTECTION AREA
MANGROVE CREATION - ±24.1 acres
CHANNEL CREATION - ±11.6 acres
UPLAND HAMMOCK CREATION- ±12.9 acres
MUD FLAT/TIDE POOL CREATION- ±8.5 acres
SEAGRASS CREATION- ±7.7 acres
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MITIGATION PLAN
MILLER LEGG
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
937503
VPP-1
8
33
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 8 of 33
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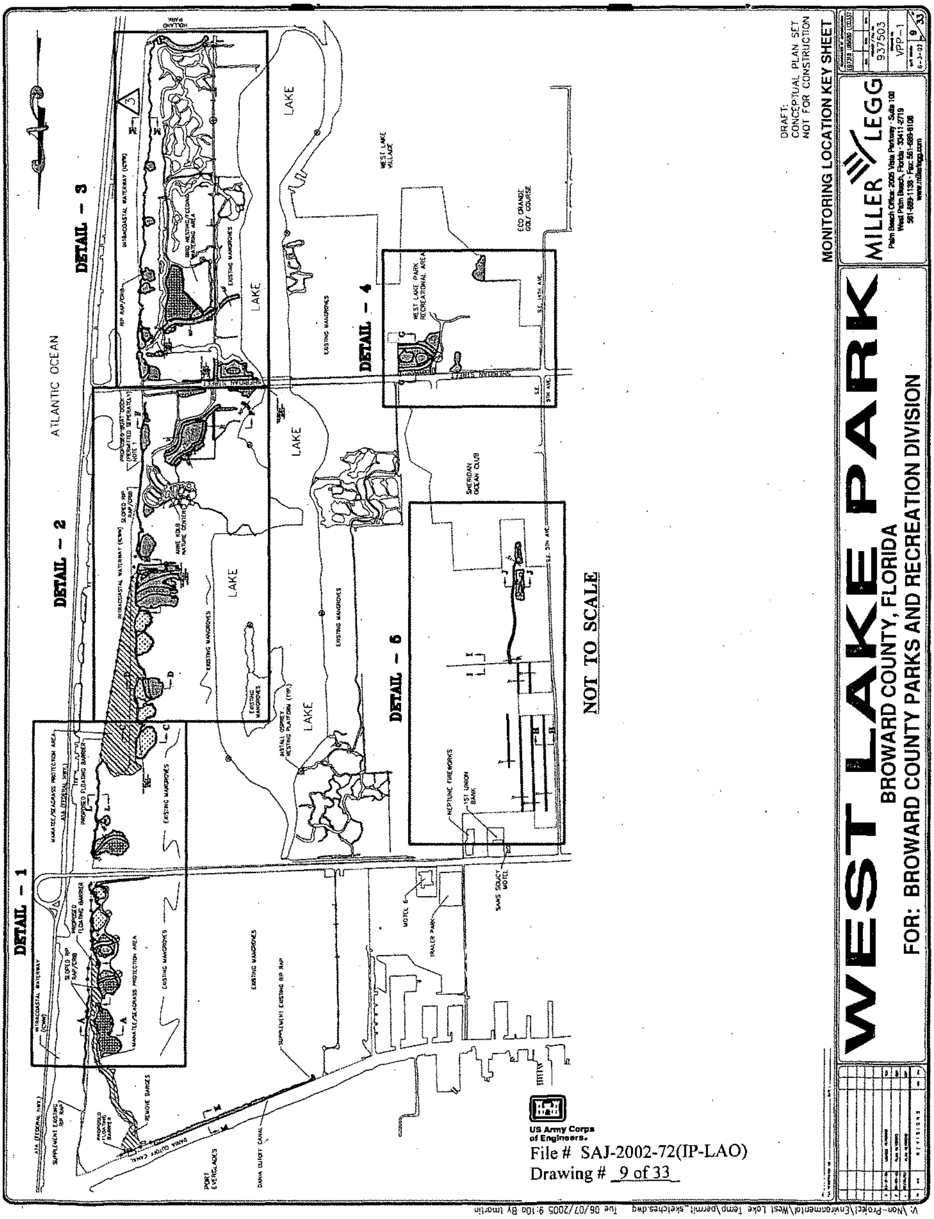
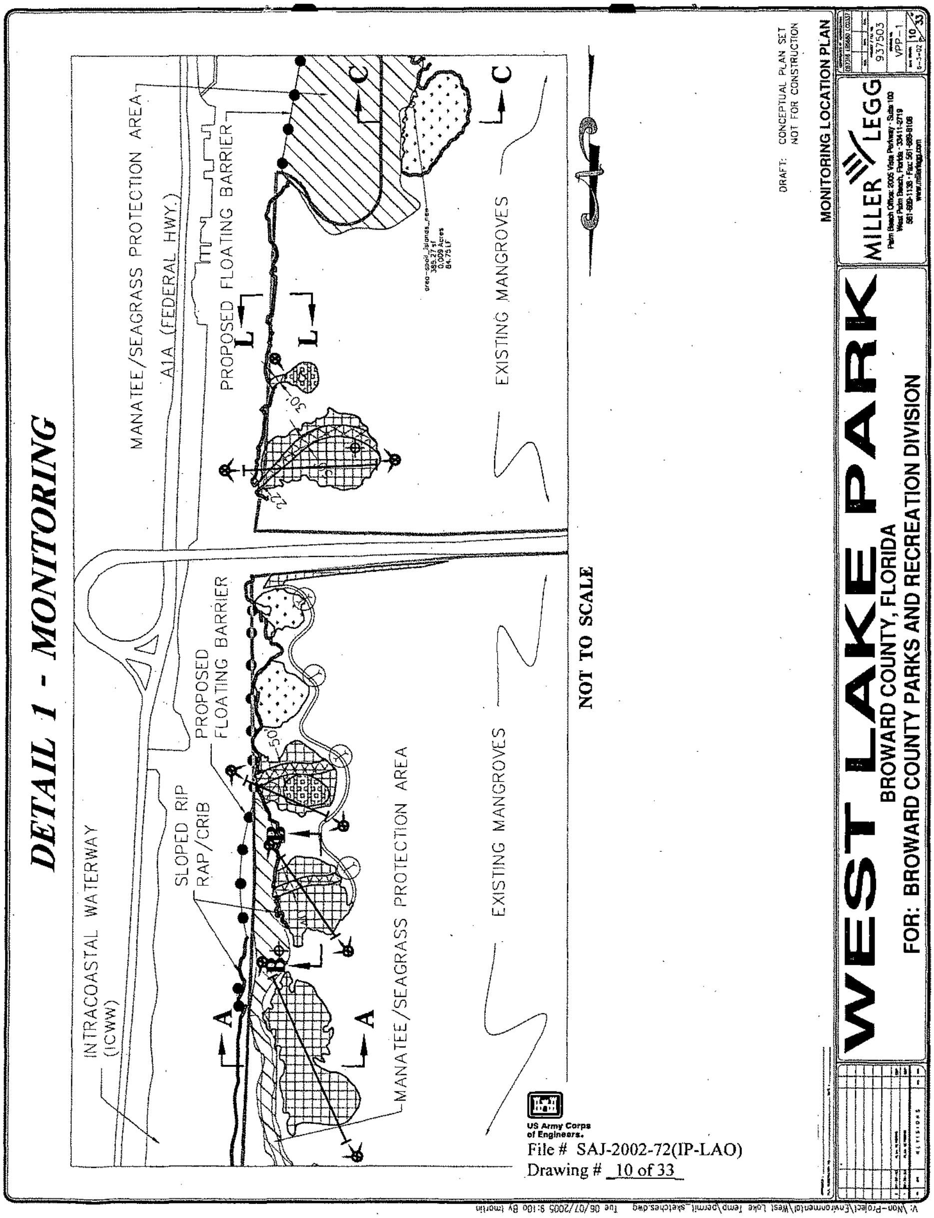
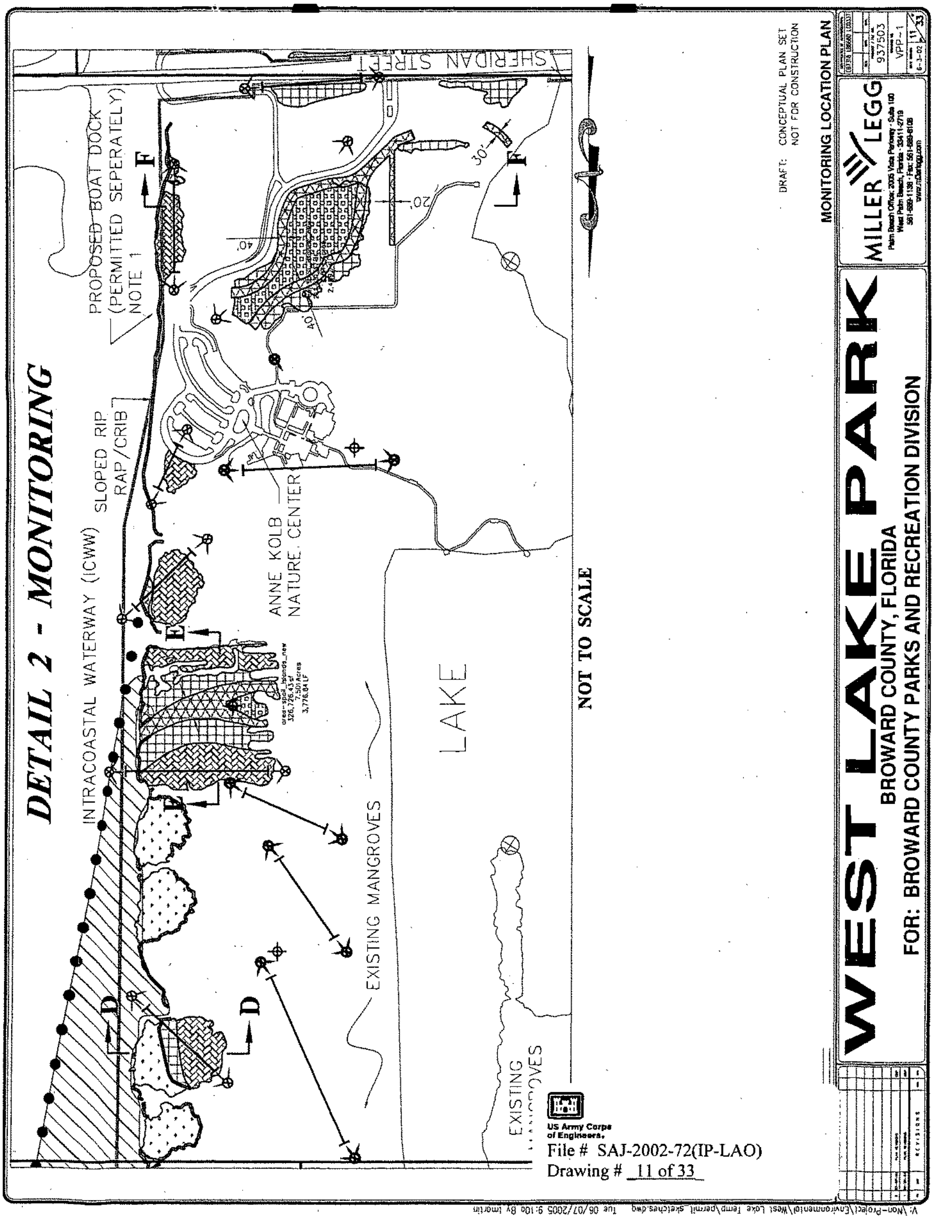
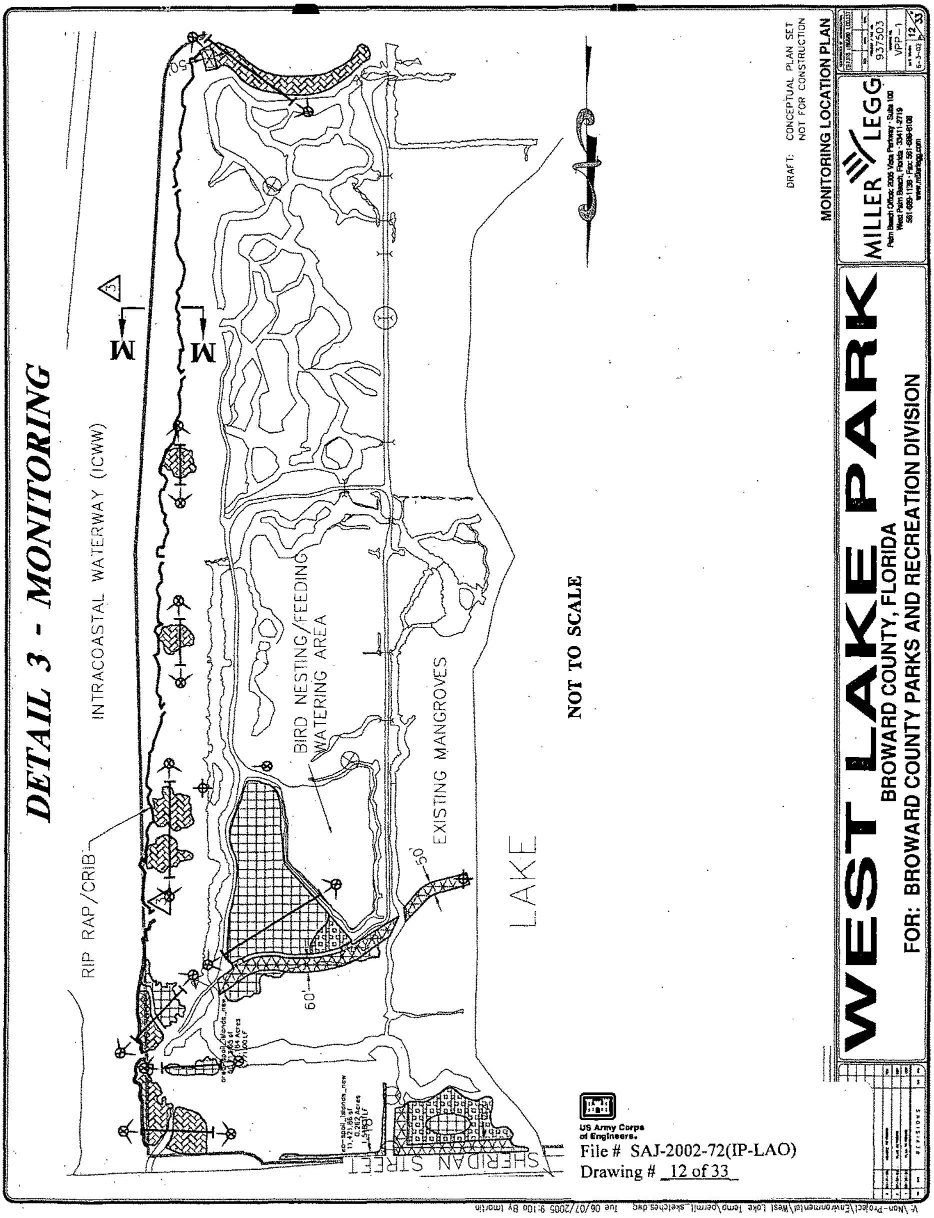
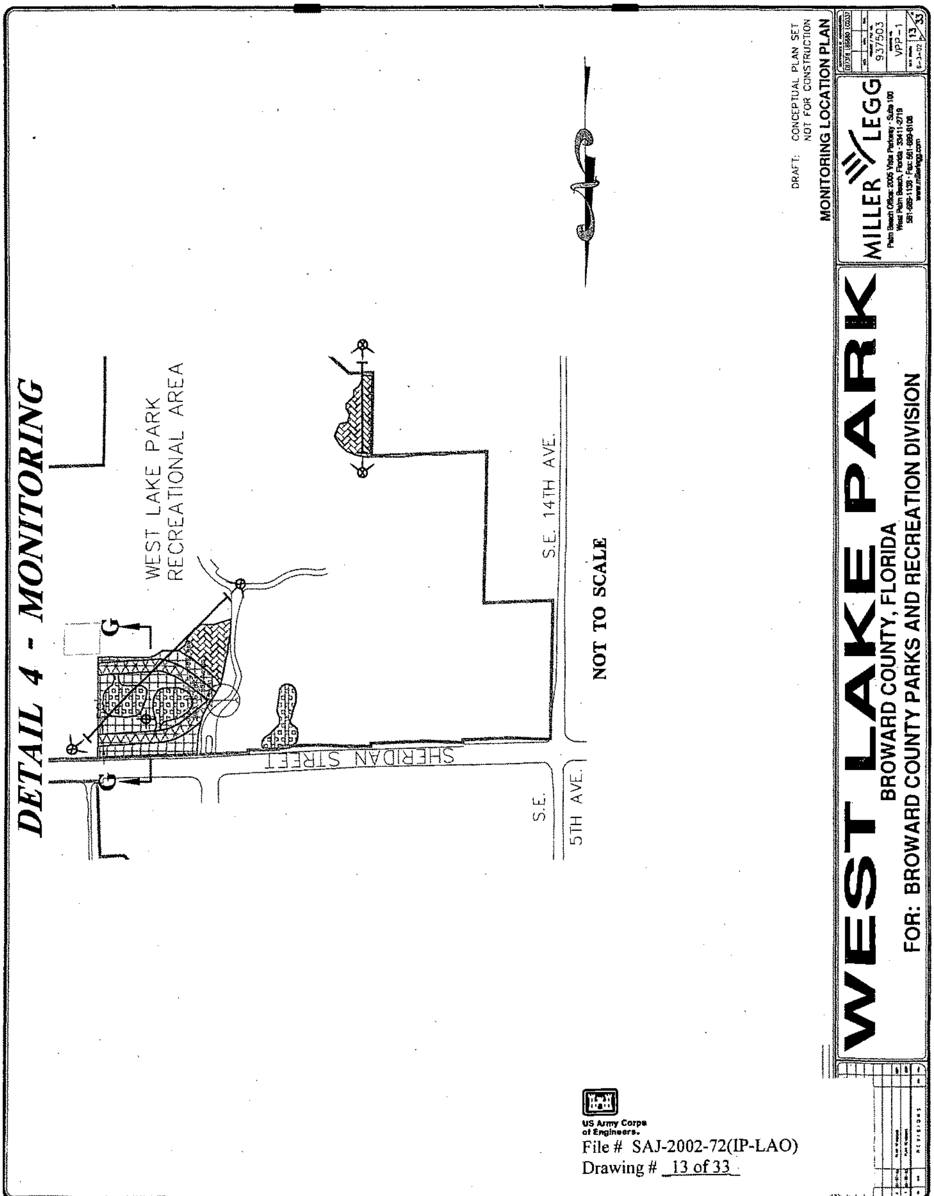
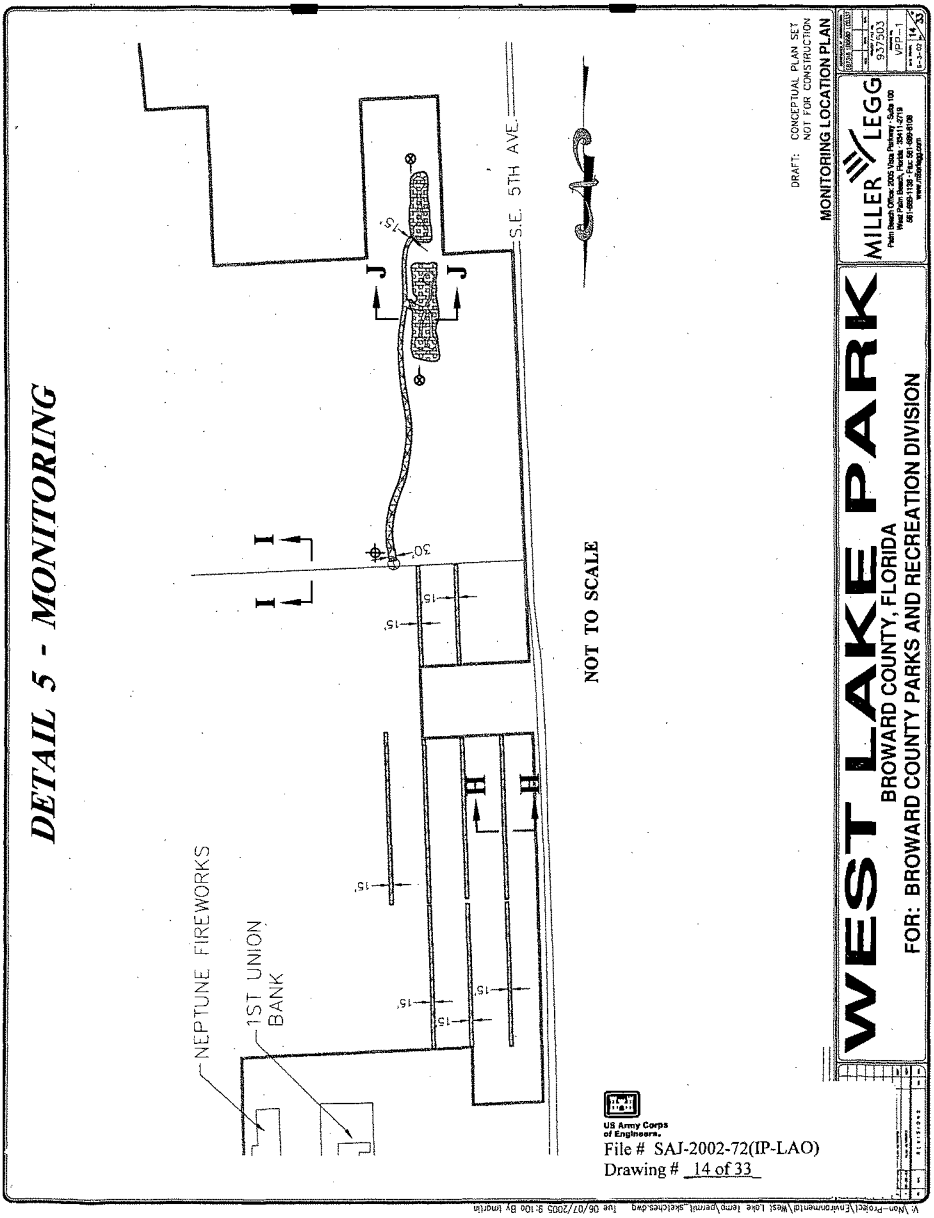

WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MONITORING LOCATION KEY SHEET
DRAFT:
CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION
MILLER LEGG
937503
VPP-1
NOT TO SCALE
DETAIL - 1
DETAIL - 2
DETAIL - 3
DETAIL - 4
DETAIL - 6
ATLANTIC OCEAN
LAKE
EXISTING MANGROVES
INTRACOASTAL WATERWAY (ICWW)
SHERIDAN STREET
DANIA CUTOFF CANAL
PORT EVERGLADES
ANNE KOLB NATURE CENTER
SHERIDAN OCEAN CLUB
WEST LAKE VILLAGE
ECO GRANDE GOLF COURSE
WEST LAKE PARK RECREATIONAL AREA
MOTEL 6
TRAILER PARK
SANS SOUCY MOTEL
NEPTUNE FIREWORKS
1ST UNION BANK
HOLLAND PARK
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 9 of 33

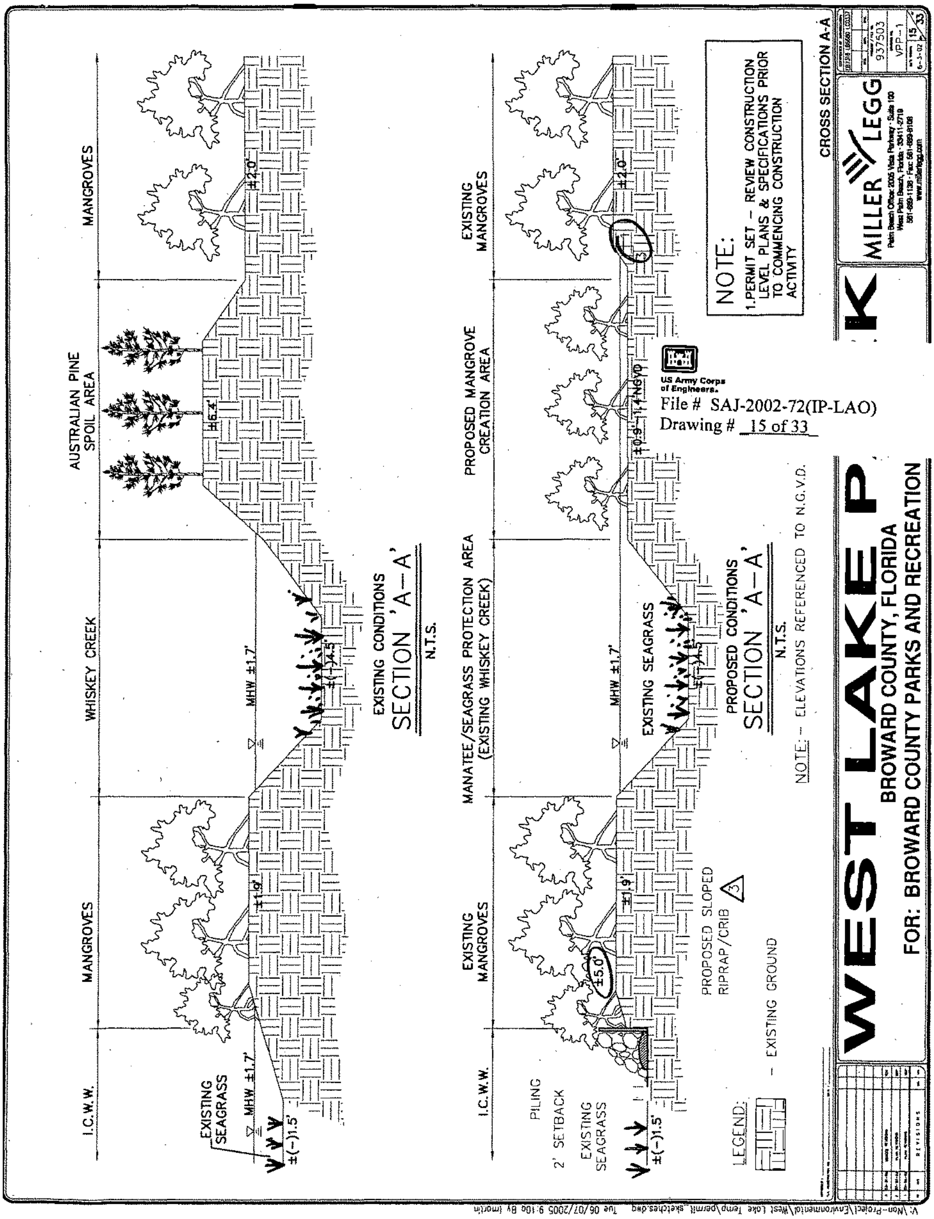

DETAIL 1 - MONITORING
INTRACOASTAL WATERWAY (ICWW)
SLOPED RIP RAP/CRIB
PROPOSED FLOATING BARRIER
MANATEE/SEAGRASS PROTECTION AREA
EXISTING MANGROVES
MANATEE/SEAGRASS PROTECTION AREA
A1A (FEDERAL HWY.)
PROPOSED FLOATING BARRIER
EXISTING MANGROVES
NOT TO SCALE
A
B
L
C
US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 10 of 33
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MONITORING LOCATION PLAN
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
10
33


DETAIL 2 - MONITORING
INTRACOASTAL WATERWAY (ICWW)
SLOPED RIP RAP/CRIB
PROPOSED BOAT DOCK (PERMITTED SEPERATELY) NOTE 1
SHERIDAN STREET
ANNE KOLB NATURE CENTER
EXISTING MANGROVES
LAKE
EXISTING MANGROVES
NOT TO SCALE
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MONITORING LOCATION PLAN
MILLER LEGG
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
937503
VPP-1
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 11 of 33


DETAIL 3 - MONITORING
INTRACOASTAL WATERWAY (ICWW)
RIP RAP/CRIB
BIRD NESTING/FEEDING WATERING AREA
EXISTING MANGROVES
LAKE
NOT TO SCALE
SHERIDAN STREET
60'
50'
US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 12 of 33
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MONITORING LOCATION PLAN
MILLER LEGG
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
937503
VPP-1


DETAIL 4 - MONITORING
WEST LAKE PARK
RECREATIONAL AREA
G
G
SHERIDAN STREET
S.E. 14TH AVE.
S.E.
5TH AVE.
NOT TO SCALE
DRAFT: CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION
MONITORING LOCATION PLAN
MILLER LEGG
937503
VPP-1
13
33
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
REVISIONS
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 13 of 33


DETAIL 5 - MONITORING
NEPTUNE FIREWORKS
1ST UNION BANK
S.E. 5TH AVE.
NOT TO SCALE
15'
30'
H
I
J
US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 14 of 33
DRAFT: CONCEPTUAL PLAN SET NOT FOR CONSTRUCTION
MONITORING LOCATION PLAN
MILLER LEGG
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
937503
VPP-1
14
33


I.C.W.W.
MANGROVES
WHISKEY CREEK
AUSTRALIAN PINE SPOIL AREA
MANGROVES
EXISTING SEAGRASS
MHW ±1.7'
±(−)1.5'
±1.9'
±(−)4.5'
±6.4'
±2.0'
EXISTING CONDITIONS
SECTION 'A—A'
N.T.S.
I.C.W.W.
EXISTING MANGROVES
MANATEE/SEAGRASS PROTECTION AREA (EXISTING WHISKEY CREEK)
PROPOSED MANGROVE CREATION AREA
EXISTING MANGROVES
PILING
2' SETBACK
EXISTING SEAGRASS
±5.0'
±1.9'
MHW ±1.7'
EXISTING SEAGRASS
±0.9'-1.4'NGVD
±2.0'
PROPOSED SLOPED RIPRAP/CRIB
PROPOSED CONDITIONS
SECTION 'A—A'
N.T.S.
LEGEND:
- EXISTING GROUND
NOTE: - ELEVATIONS REFERENCED TO N.G.V.D.
NOTE:
1. PERMIT SET - REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 15 of 33
WEST LAKE P
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION
MILLER LEGG
CROSS SECTION A-A
937503
VPP-1
15
33
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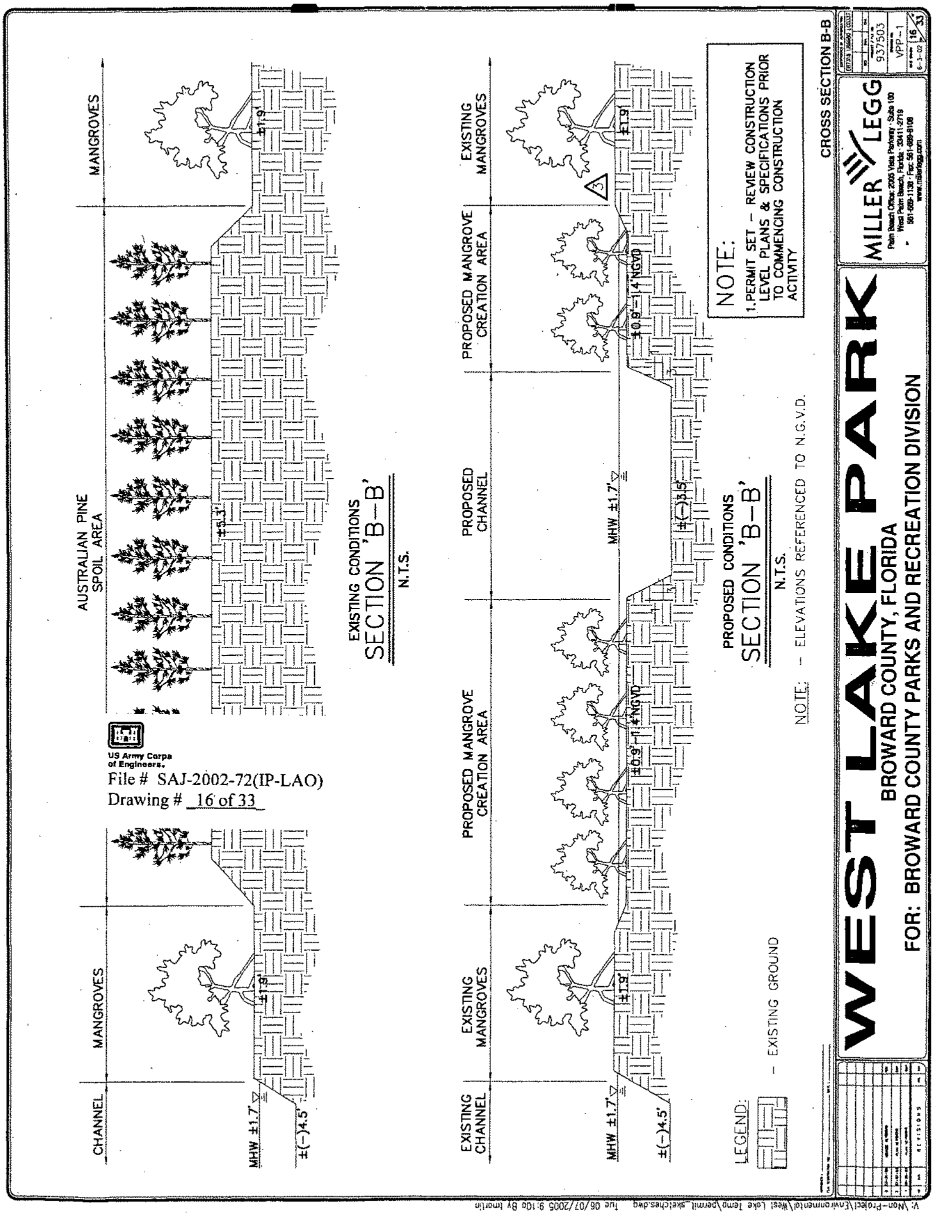
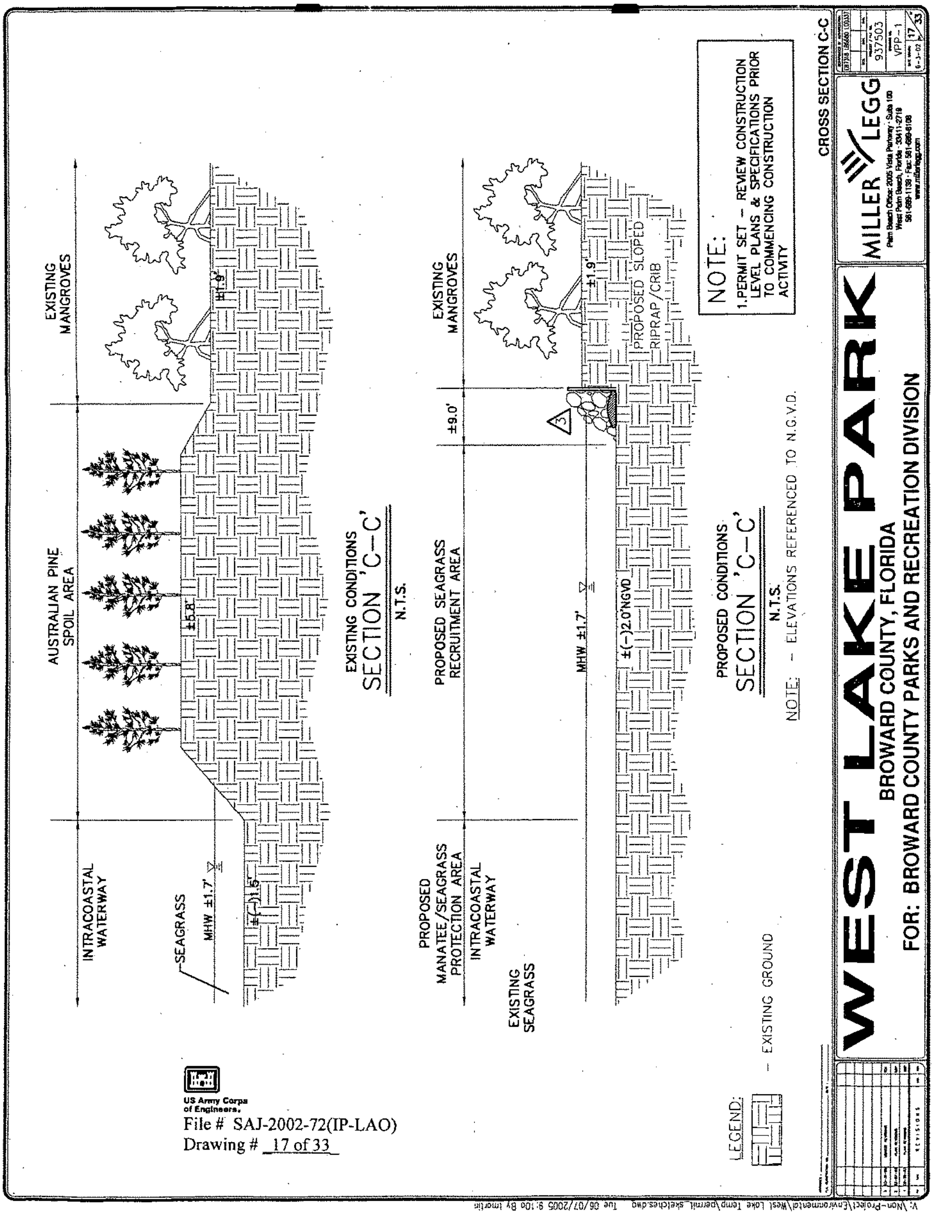


CHANNEL
MANGROVES
AUSTRALIAN PINE SPOIL AREA
MANGROVES
MHW ±1.7'
±(-)4.5'
±1.9'
±5.3'
±1.9'
EXISTING CONDITIONS
SECTION 'B–B'
N.T.S.
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 16 of 33
EXISTING CHANNEL
EXISTING MANGROVES
PROPOSED MANGROVE CREATION AREA
PROPOSED CHANNEL
PROPOSED MANGROVE CREATION AREA
EXISTING MANGROVES
MHW ±1.7'
±(-)4.5'
±1.9'
±0.9'–1.4'NGVD
MHW ±1.7'
±(-)3.5'
±0.9'–1.4'NGVD
±1.9'
PROPOSED CONDITIONS
SECTION 'B–B'
N.T.S.
NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
LEGEND:
– EXISTING GROUND
NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.
CROSS SECTION B-B
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
16
33
6-3-02
REVISIONS


EXISTING MANGROVES
AUSTRALIAN PINE SPOIL AREA
INTRACOASTAL WATERWAY
SEAGRASS
MHW ±1.7'
±(-)1.5'
±5.8'
±1.9'
EXISTING CONDITIONS
SECTION 'C—C'
N.T.S.
PROPOSED SEAGRASS RECRUITMENT AREA
EXISTING MANGROVES
PROPOSED MANATEE/SEAGRASS PROTECTION AREA
INTRACOASTAL WATERWAY
EXISTING SEAGRASS
±9.0'
MHW ±1.7'
±(-)2.0'NGVD
±1.9'
PROPOSED SLOPED RIPRAP/CRIB
3
PROPOSED CONDITIONS
SECTION 'C—C'
N.T.S.
NOTE: - ELEVATIONS REFERENCED TO N.G.V.D.
NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
LEGEND:
- EXISTING GROUND
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 17 of 33
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
CROSS SECTION C-C
937503
VPP-1
17 33
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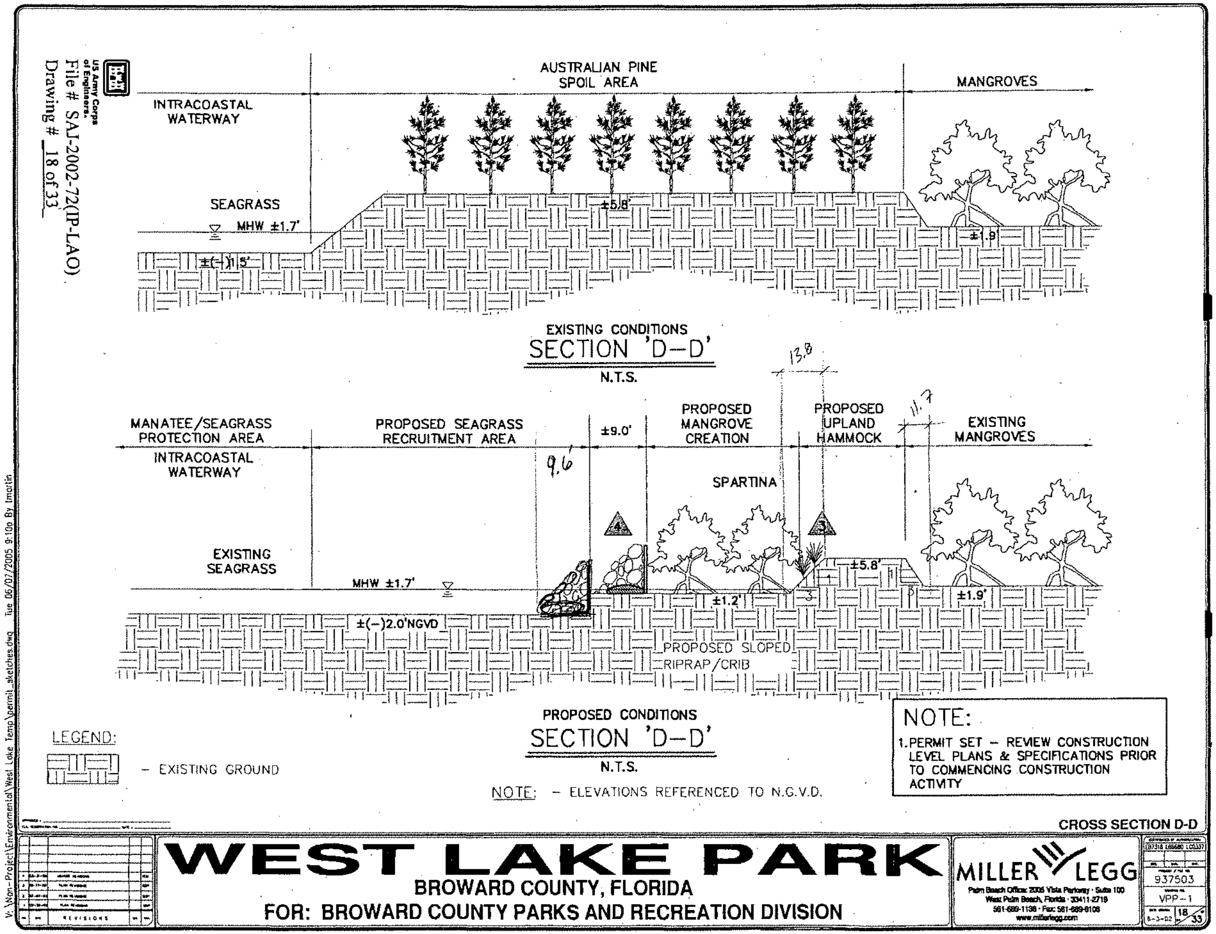
AUSTRALIAN PINE SPOIL AREA
MANGROVES
INTRACOASTAL WATERWAY
SEAGRASS
MHW ±1.7'
±(-)1.5'
±5.8'
±1.9'
EXISTING CONDITIONS
SECTION 'D-D'
N.T.S.
MANATEE/SEAGRASS PROTECTION AREA
PROPOSED SEAGRASS RECRUITMENT AREA
±9.0'
PROPOSED MANGROVE CREATION
PROPOSED UPLAND HAMMOCK
EXISTING MANGROVES
INTRACOASTAL WATERWAY
13.8
11.7
9.6
SPARTINA
EXISTING SEAGRASS
MHW ±1.7'
±(-)2.0'NGVD
±1.2'
±5.8'
±1.9'
PROPOSED SLOPED RIPRAP/CRIB
PROPOSED CONDITIONS
SECTION 'D-D'
N.T.S.
NOTE: - ELEVATIONS REFERENCED TO N.G.V.D.
LEGEND:
- EXISTING GROUND
NOTE:
1. PERMIT SET - REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
CROSS SECTION D-D
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
18
33
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 18 of 33
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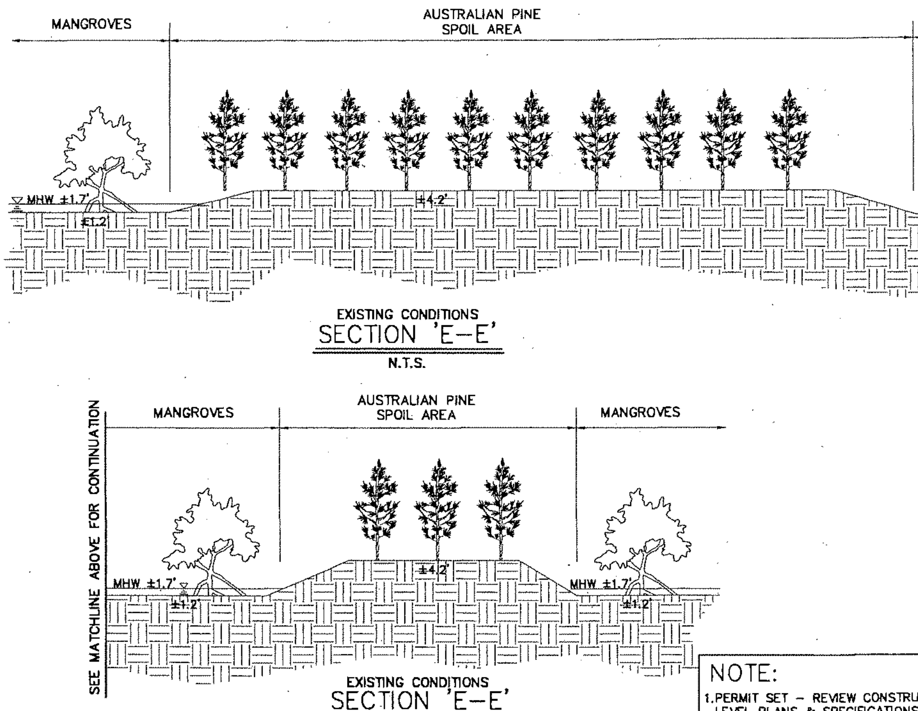

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

LEGEND:

– EXISTING GROUND

NOTE:

1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 19 of 33

CROSS SECTION E-E

WEST LAKE PARK

BROWARD COUNTY, FLORIDA

FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION

MILLER LEGG

Palm Beach Office: 2005 Vista Parkway · Suite 100
West Palm Beach, Florida · 33411-2719
561-689-1138 · Fax: 561-689-8108
www.millerlegg.com

937503

VPP–1

6-3-02

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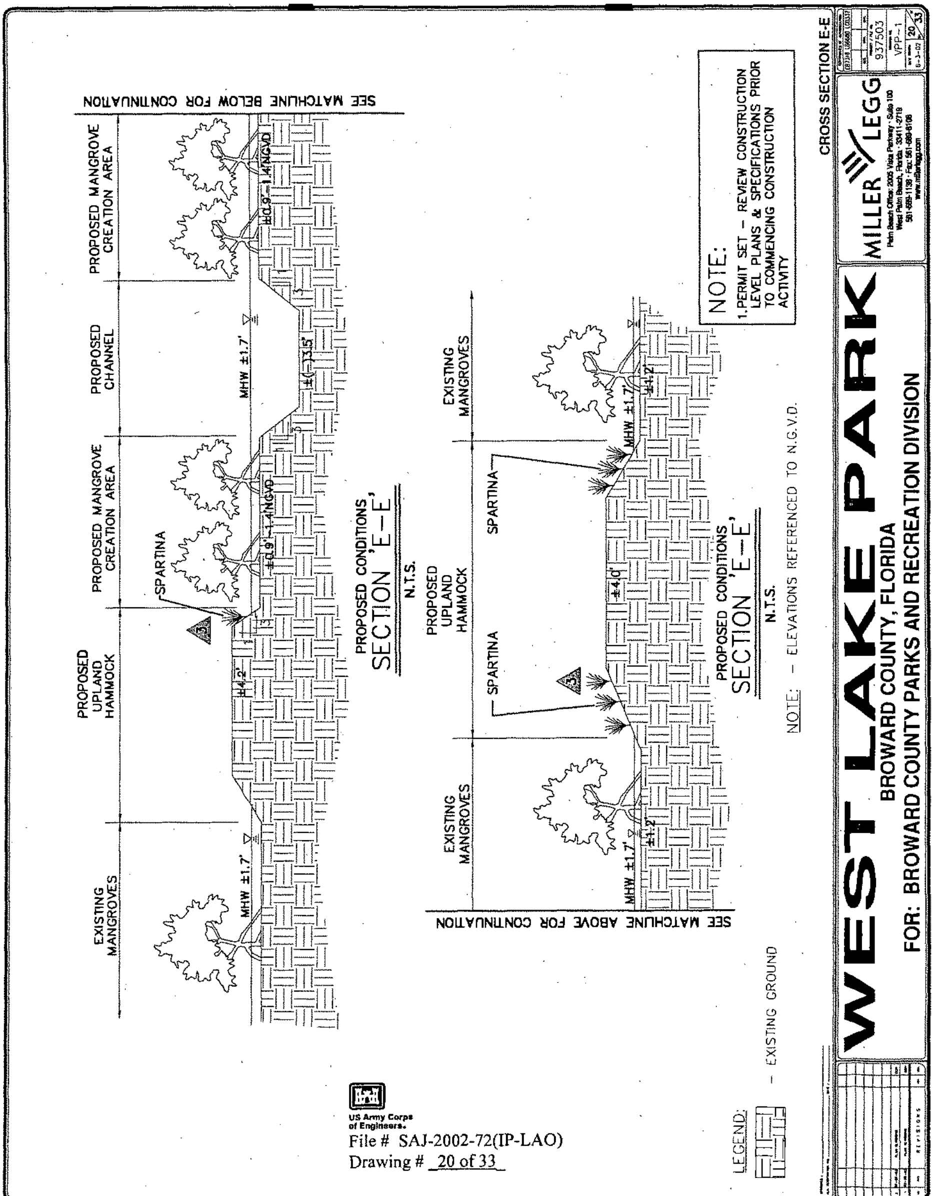
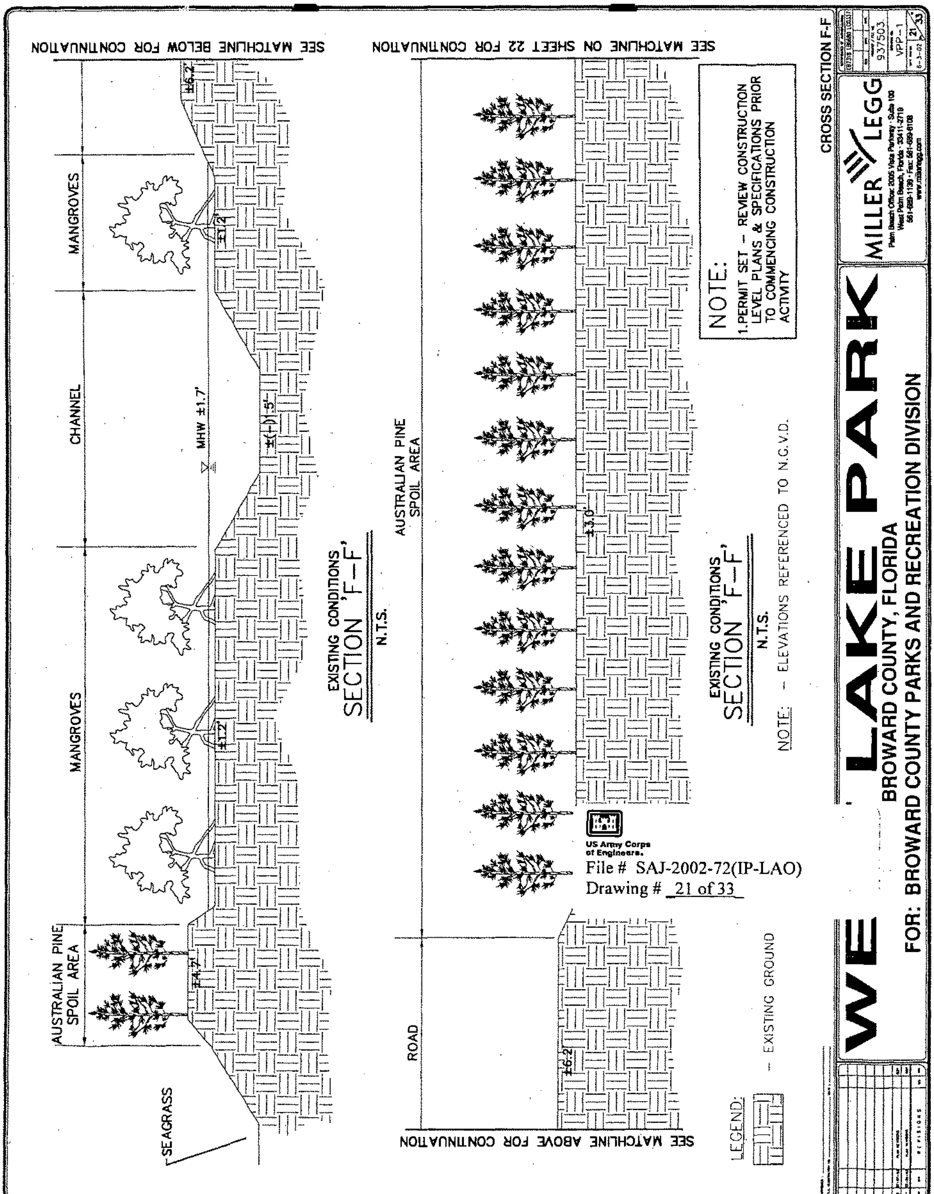
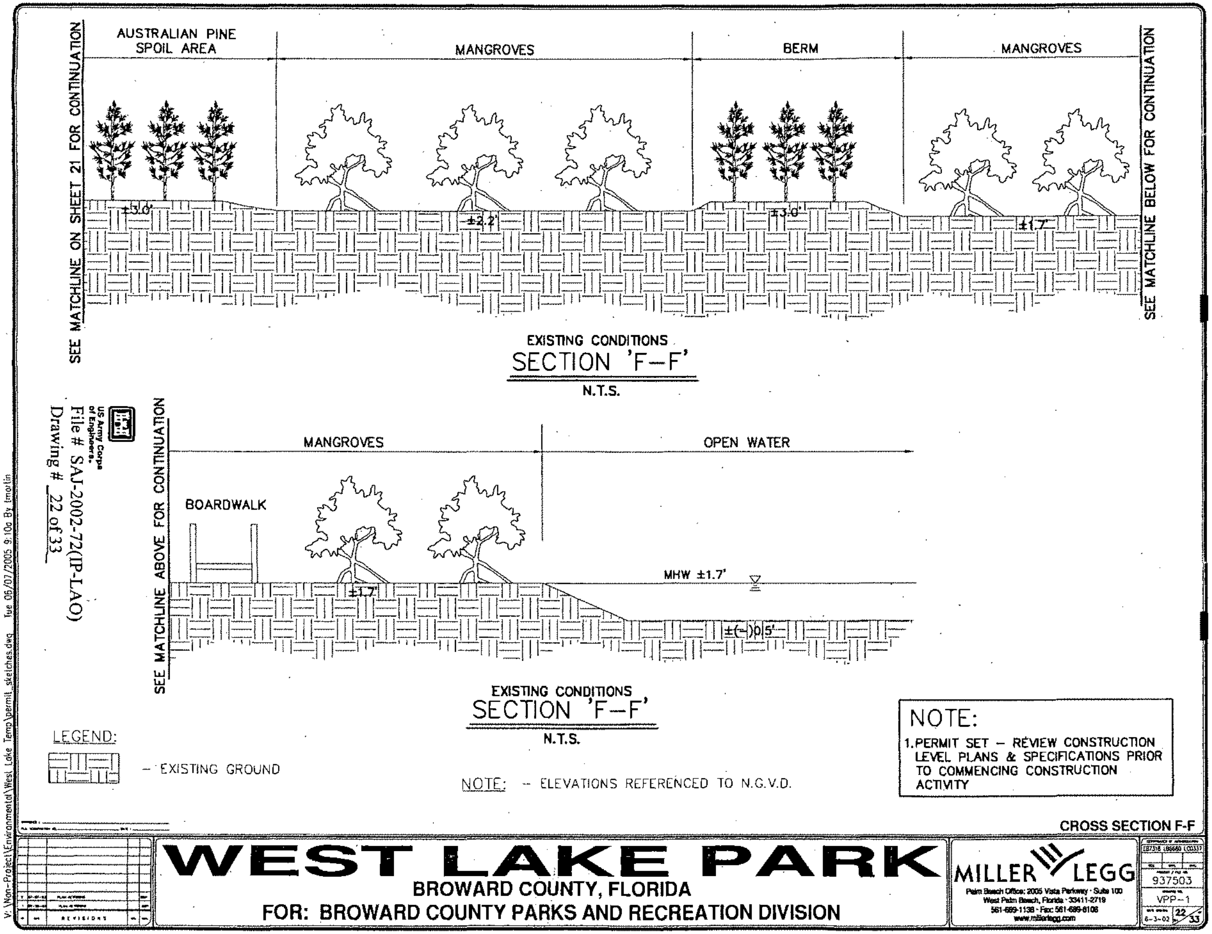
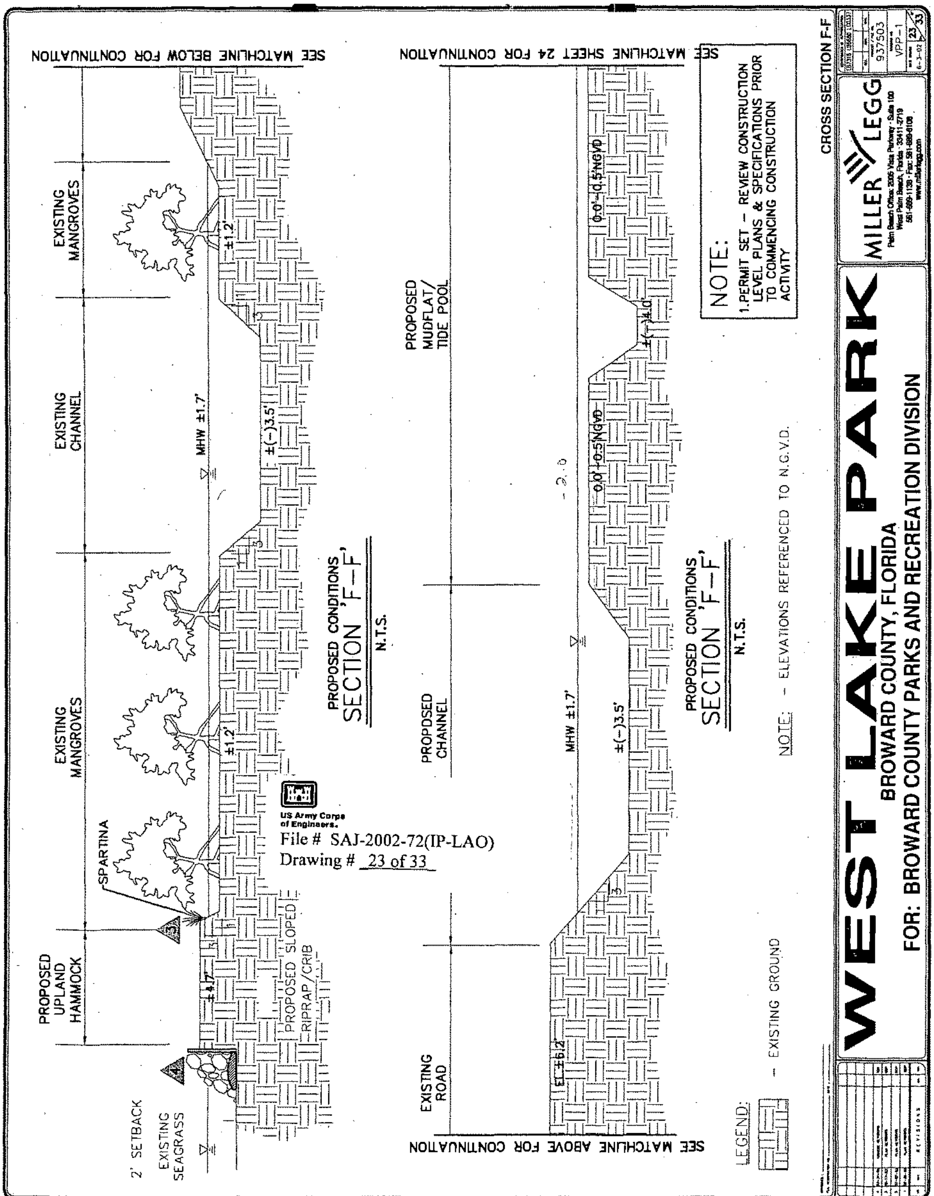


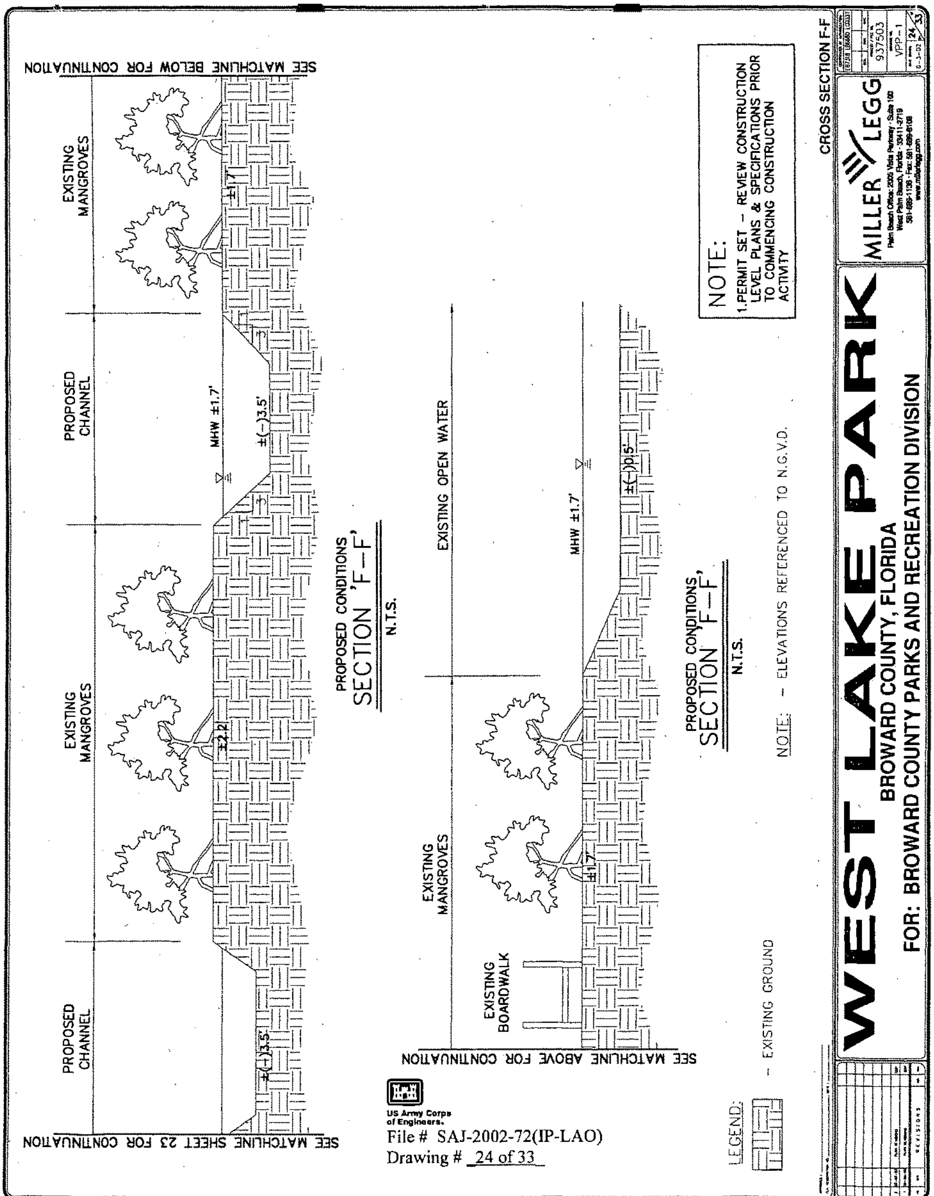
File # SAJ-2002-72(IP-LAO)
Drawing # 20 of 33

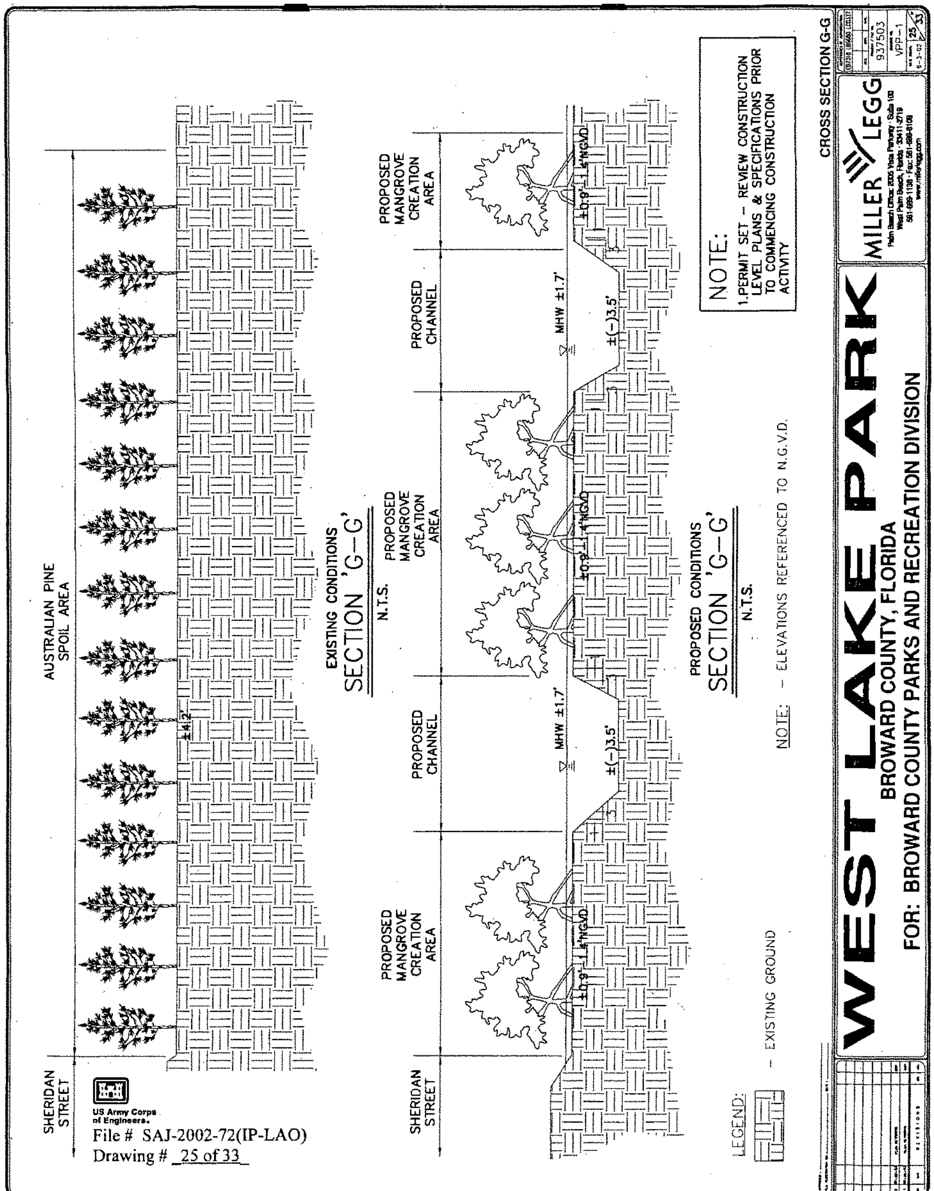

SEE MATCHLINE BELOW FOR CONTINUATION
SEE MATCHLINE ON SHEET 22 FOR CONTINUATION
SEE MATCHLINE ABOVE FOR CONTINUATION
SEAGRASS
AUSTRALIAN PINE SPOIL AREA
MANGROVES
CHANNEL
MANGROVES
±6.2'
±4.7'
±1.2'
±1.2'
MHW ±1.7'
±(-)1.5'
±3.0'
ROAD
AUSTRALIAN PINE SPOIL AREA
EXISTING CONDITIONS
SECTION 'F—F'
N.T.S.
EXISTING CONDITIONS
SECTION 'F—F'
N.T.S.
NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.
LEGEND:
– EXISTING GROUND
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 21 of 33
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
CROSS SECTION F-F
937503
VPP-1
21
33


SEE MATCHLINE ON SHEET 21 FOR CONTINUATION
AUSTRALIAN PINE SPOIL AREA
MANGROVES
BERM
MANGROVES
SEE MATCHLINE BELOW FOR CONTINUATION
±3.0'
±2.2'
±3.0'
±1.7'
EXISTING CONDITIONS
SECTION 'F–F'
N.T.S.
SEE MATCHLINE ABOVE FOR CONTINUATION
MANGROVES
OPEN WATER
BOARDWALK
±1.7'
MHW ±1.7'
±(-)0.5'
EXISTING CONDITIONS
SECTION 'F–F'
N.T.S.
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 22 of 33
LEGEND:
– EXISTING GROUND
NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.
NOTE:
1.PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
CROSS SECTION F-F
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
22
33
REVISIONS



SEE MATCHLINE BELOW FOR CONTINUATION
EXISTING MANGROVES
EXISTING CHANNEL
EXISTING MANGROVES
SPARTINA
PROPOSED UPLAND HAMMOCK
2' SETBACK
EXISTING SEAGRASS
MHW ±1.7'
±1.2'
±(-)3.5'
±1.2'
±4.7'
PROPOSED SLOPED RIPRAP/CRIB
PROPOSED CONDITIONS
SECTION 'F–F'
N.T.S.
US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 23 of 33
SEE MATCHLINE SHEET 24 FOR CONTINUATION
PROPOSED MUDFLAT/ TIDE POOL
PROPOSED CHANNEL
EXISTING ROAD
0.0'–0.5'NGVD
±(-)4.0'
0.0'–0.5'NGVD
MHW ±1.7'
±(-)3.5'
EL ±6.2'
PROPOSED CONDITIONS
SECTION 'F–F'
N.T.S.
SEE MATCHLINE ABOVE FOR CONTINUATION
NOTE:
1.PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.
LEGEND:
– EXISTING GROUND
CROSS SECTION F-F
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
23 of 33
6-3-02


SEE MATCHLINE SHEET 23 FOR CONTINUATION
SEE MATCHLINE BELOW FOR CONTINUATION
PROPOSED CHANNEL
EXISTING MANGROVES
PROPOSED CHANNEL
EXISTING MANGROVES
MHW ±1.7'
±(-)3.5'
±2.2'
±1.7'
PROPOSED CONDITIONS
SECTION 'F—F'
N.T.S.
SEE MATCHLINE ABOVE FOR CONTINUATION
EXISTING BOARDWALK
EXISTING MANGROVES
EXISTING OPEN WATER
MHW ±1.7'
±(-)0.5'
PROPOSED CONDITIONS
SECTION 'F—F'
N.T.S.
NOTE: - ELEVATIONS REFERENCED TO N.G.V.D.
LEGEND:
- EXISTING GROUND
NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
CROSS SECTION F-F
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
24
33
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 24 of 33


AUSTRALIAN PINE SPOIL AREA
SHERIDAN STREET
±4.2'
EXISTING CONDITIONS
SECTION 'G–G'
N.T.S.
PROPOSED MANGROVE CREATION AREA
PROPOSED CHANNEL
PROPOSED MANGROVE CREATION AREA
PROPOSED CHANNEL
PROPOSED MANGROVE CREATION AREA
MHW ±1.7'
±(–)3.5'
±0.9'–1.4'NGVD
PROPOSED CONDITIONS
SECTION 'G–G'
N.T.S.
NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.
LEGEND:
– EXISTING GROUND
NOTE:
1.PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
CROSS SECTION G-G
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP–1
25 33
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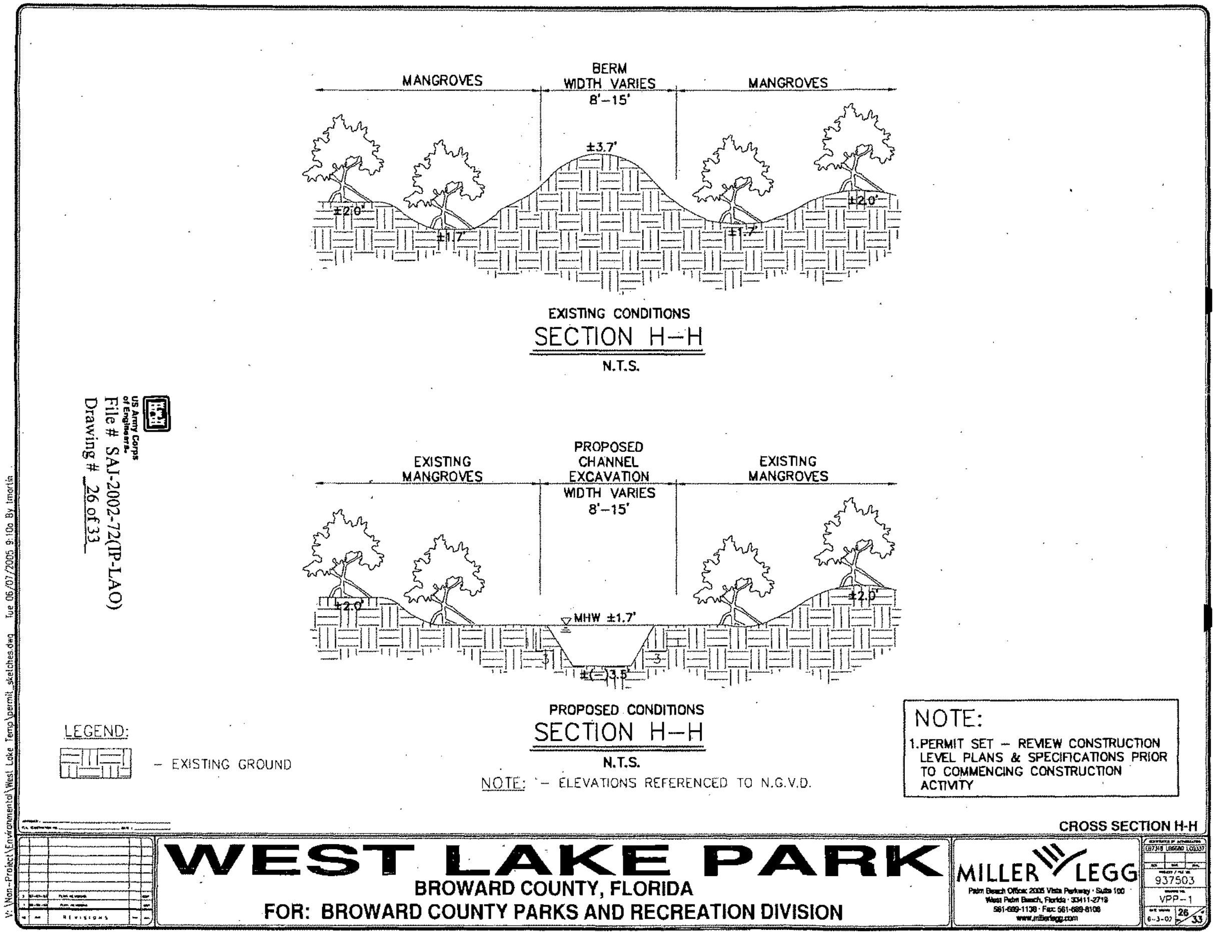
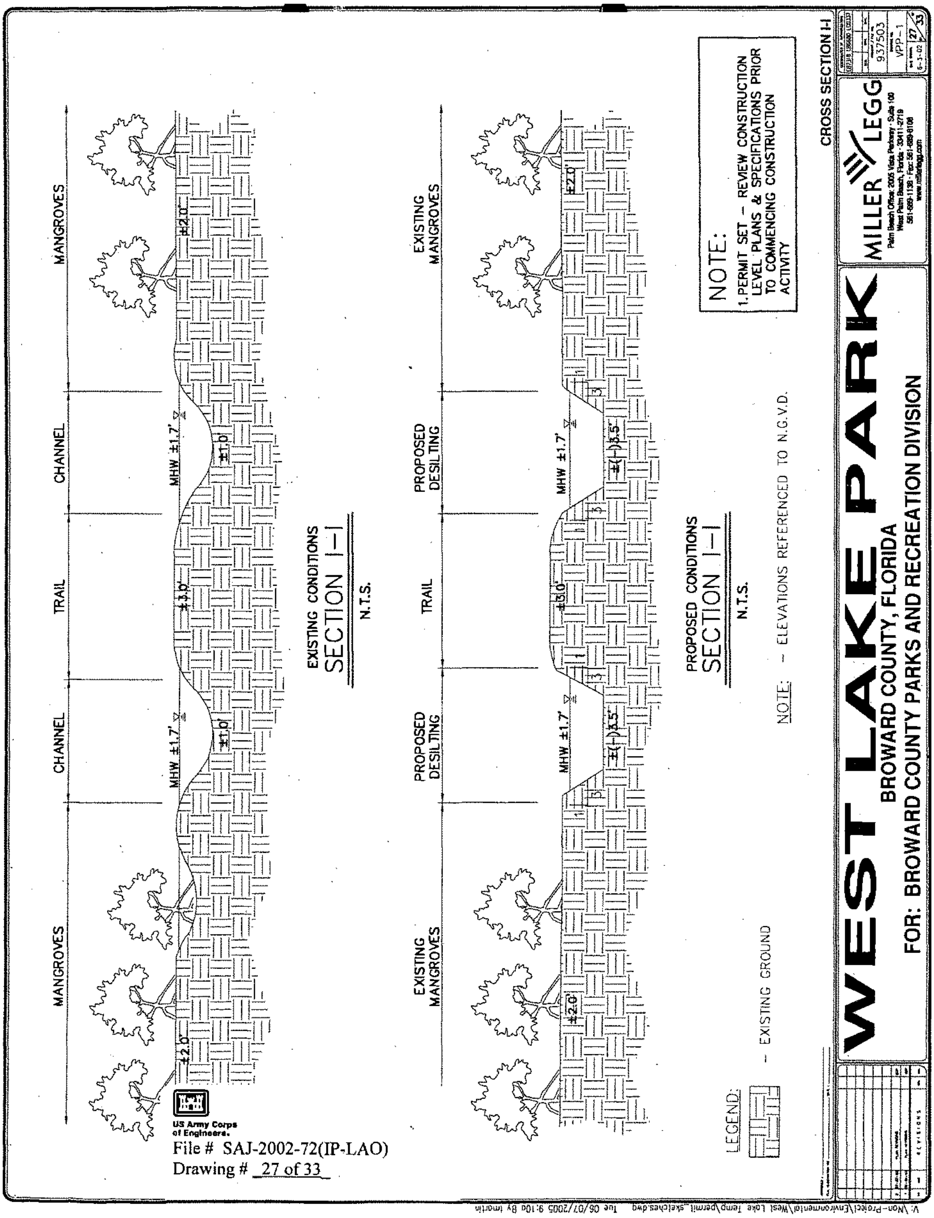
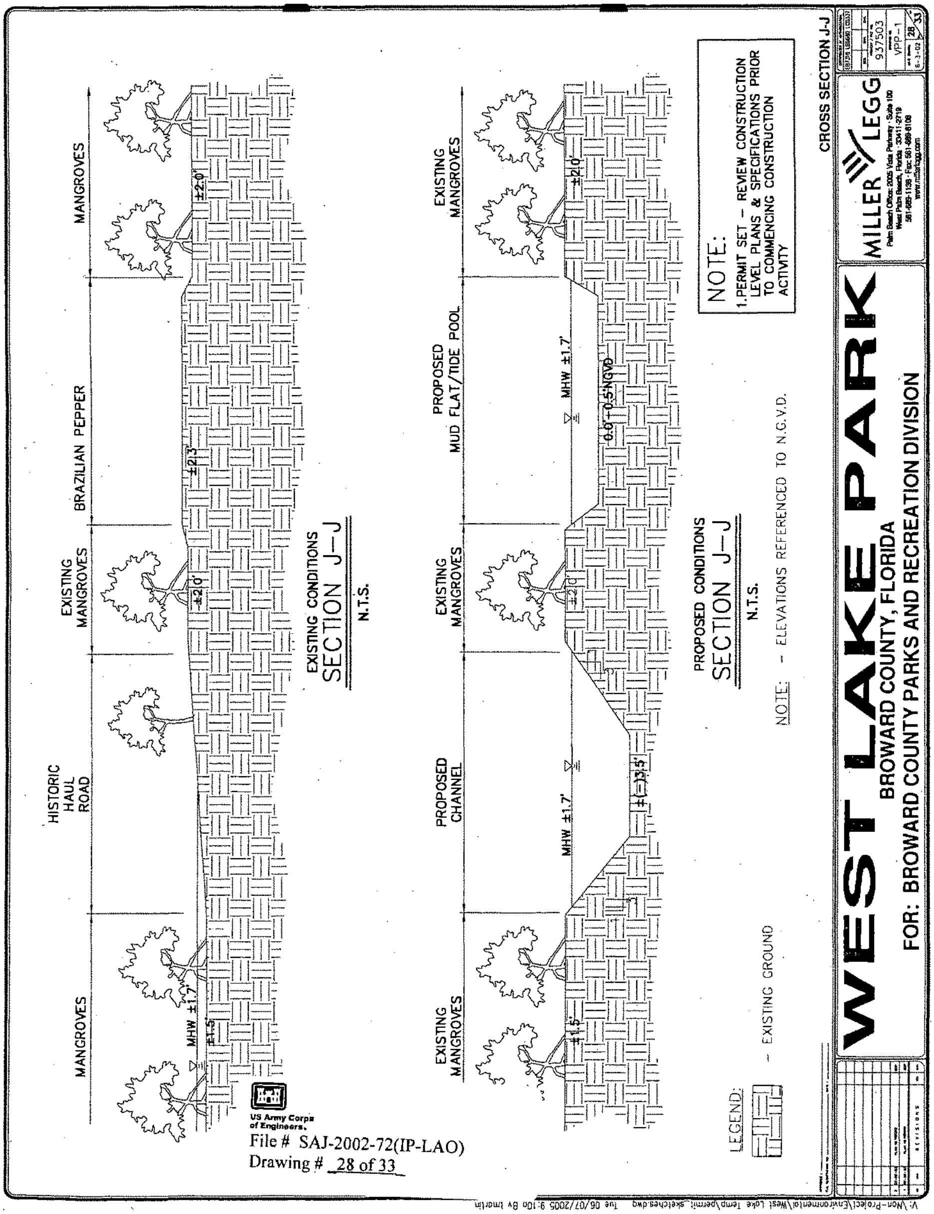
Drawing # 25 of 33


MANGROVES
BERM
WIDTH VARIES
8'-15'
MANGROVES
±3.7'
±2.0'
±1.7
±1.7'
±2.0'
EXISTING CONDITIONS
SECTION H-H
N.T.S.
EXISTING
MANGROVES
PROPOSED
CHANNEL
EXCAVATION
WIDTH VARIES
8'-15'
EXISTING
MANGROVES
±2.0'
MHW ±1.7'
±(-)3.5'
±2.0'
PROPOSED CONDITIONS
SECTION H-H
N.T.S.
NOTE: - ELEVATIONS REFERENCED TO N.G.V.D.
LEGEND:
- EXISTING GROUND
NOTE:
1. PERMIT SET - REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 26 of 33
CROSS SECTION H-H
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
6-3-02
26
33
REVISIONS


MANGROVES
CHANNEL
TRAIL
CHANNEL
MANGROVES
±2.0'
MHW ±1.7'
±1.0'
±3.0'
EXISTING CONDITIONS
SECTION I–I
N.T.S.
EXISTING MANGROVES
PROPOSED DESILTING
TRAIL
PROPOSED DESILTING
EXISTING MANGROVES
±(-)3.5'
PROPOSED CONDITIONS
SECTION I–I
N.T.S.
NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.
LEGEND:
– EXISTING GROUND
CROSS SECTION I-I
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
27 of 33
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 27 of 33
V:\Non-Project\Environmental\West Lake Temp\permit_sketches.dwg Tue 06/07/2005 9:10a By lmartin


MANGROVES
MHW ±1.7'
±1.5'
HISTORIC HAUL ROAD
EXISTING MANGROVES
±2.0'
BRAZILIAN PEPPER
±2.3'
MANGROVES
±2.0'
EXISTING CONDITIONS
SECTION J–J
N.T.S.
EXISTING MANGROVES
±1.5'
PROPOSED CHANNEL
MHW ±1.7'
±(-)3.5'
EXISTING MANGROVES
±2.0'
PROPOSED MUD FLAT/TIDE POOL
MHW ±1.7'
0.0'+0.5'NGVD
EXISTING MANGROVES
±2.0'
PROPOSED CONDITIONS
SECTION J–J
N.T.S.
NOTE: - ELEVATIONS REFERENCED TO N.G.V.D.
LEGEND:
- EXISTING GROUND
NOTE:
1.PERMIT SET - REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 28 of 33
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
CROSS SECTION J-J
937503
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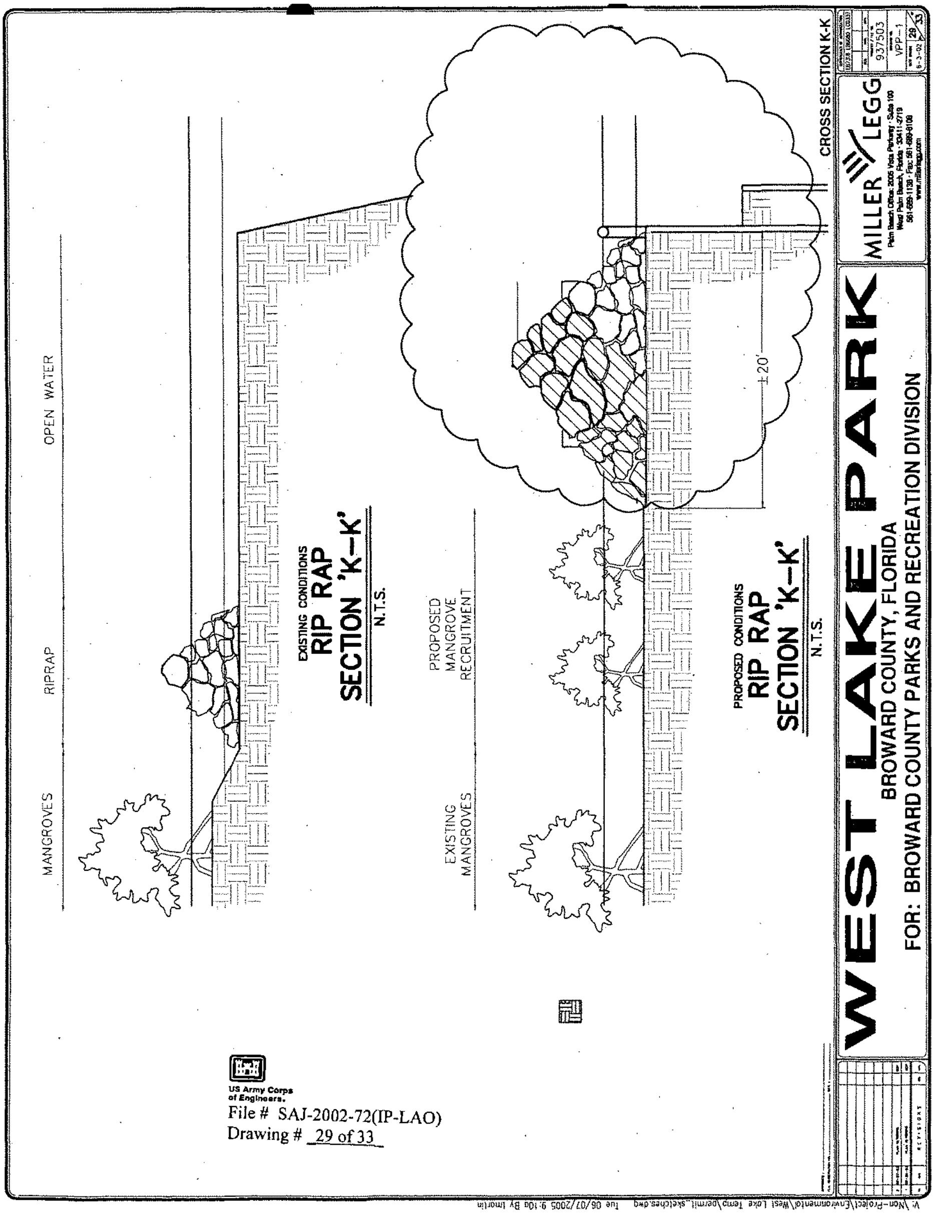
28
33
V:\Non-Project\Environmental\West Lake Temp\permit_sketches.dwg Tue 06/07/2005 9:10a By tmartin


MANGROVES
RIPRAP
OPEN WATER
EXISTING CONDITIONS
RIP RAP
SECTION 'K—K'
N.T.S.
EXISTING MANGROVES
PROPOSED MANGROVE RECRUITMENT
±20'
PROPOSED CONDITIONS
RIP RAP
SECTION 'K—K'
N.T.S.
CROSS SECTION K-K
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
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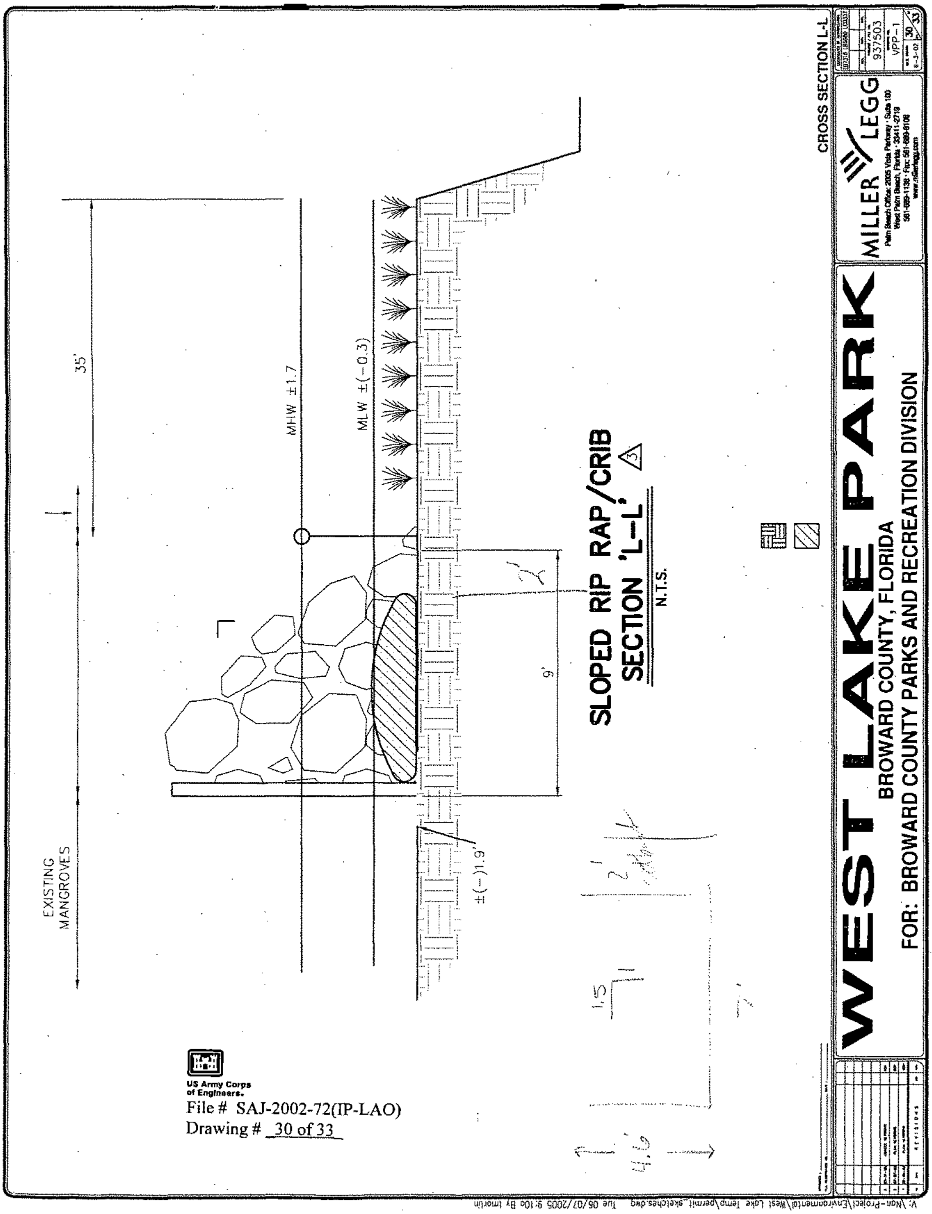
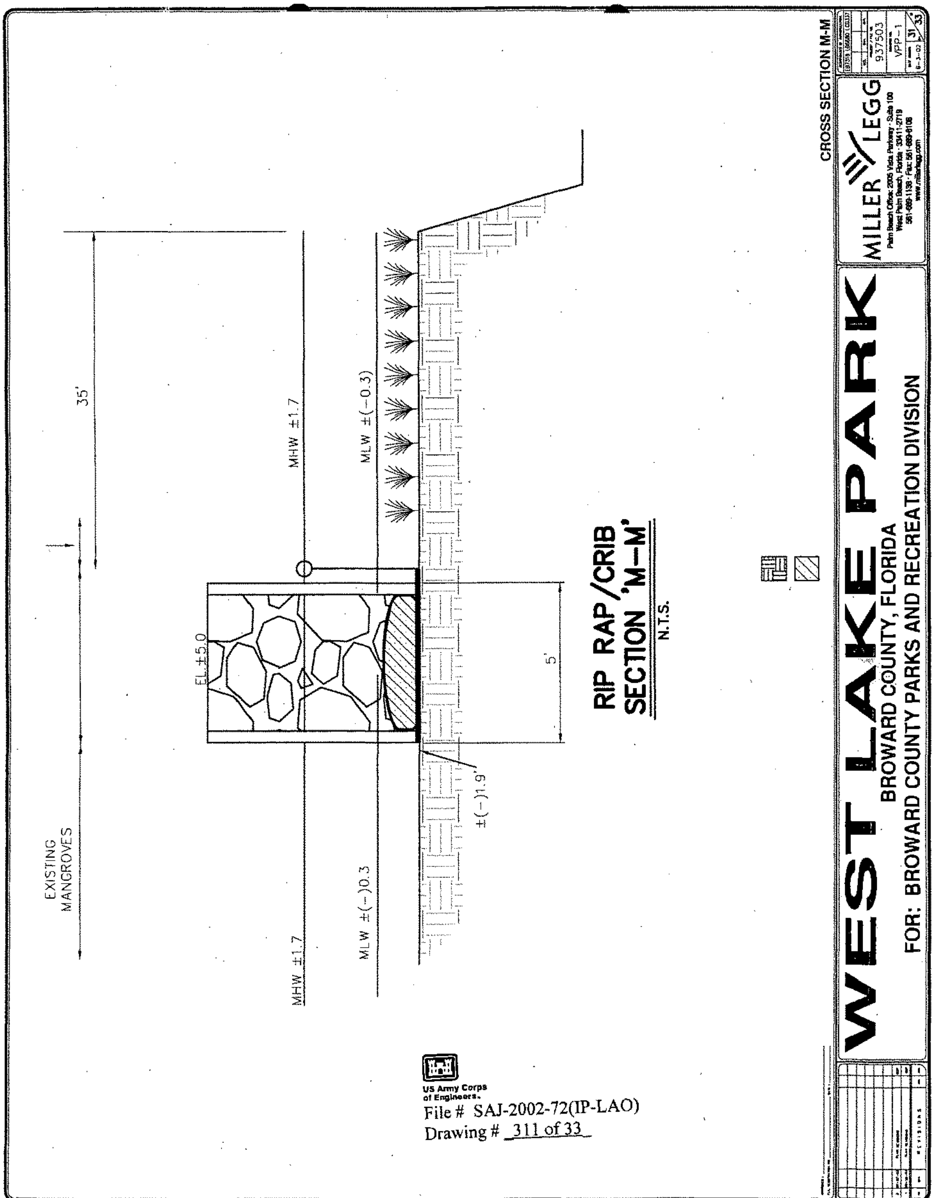
33
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 29 of 33


CROSS SECTION L-L
SLOPED RIP RAP/CRIB
SECTION 'L-L'
N.T.S.
35'
MHW ±1.7
MLW ±(-0.3)
9'
±(-)1.9'
EXISTING MANGROVES
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
30
33
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 30 of 33


CROSS SECTION M-M
35'
MHW ±1.7
MLW ±(−0.3)
EL ±5.0
5'
±(−)1.9'
EXISTING MANGROVES
MHW ±1.7
MLW ±(−)0.3
RIP RAP/CRIB
SECTION 'M—M'
N.T.S.
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
937503
VPP-1
31
33
US Army Corps of Engineers
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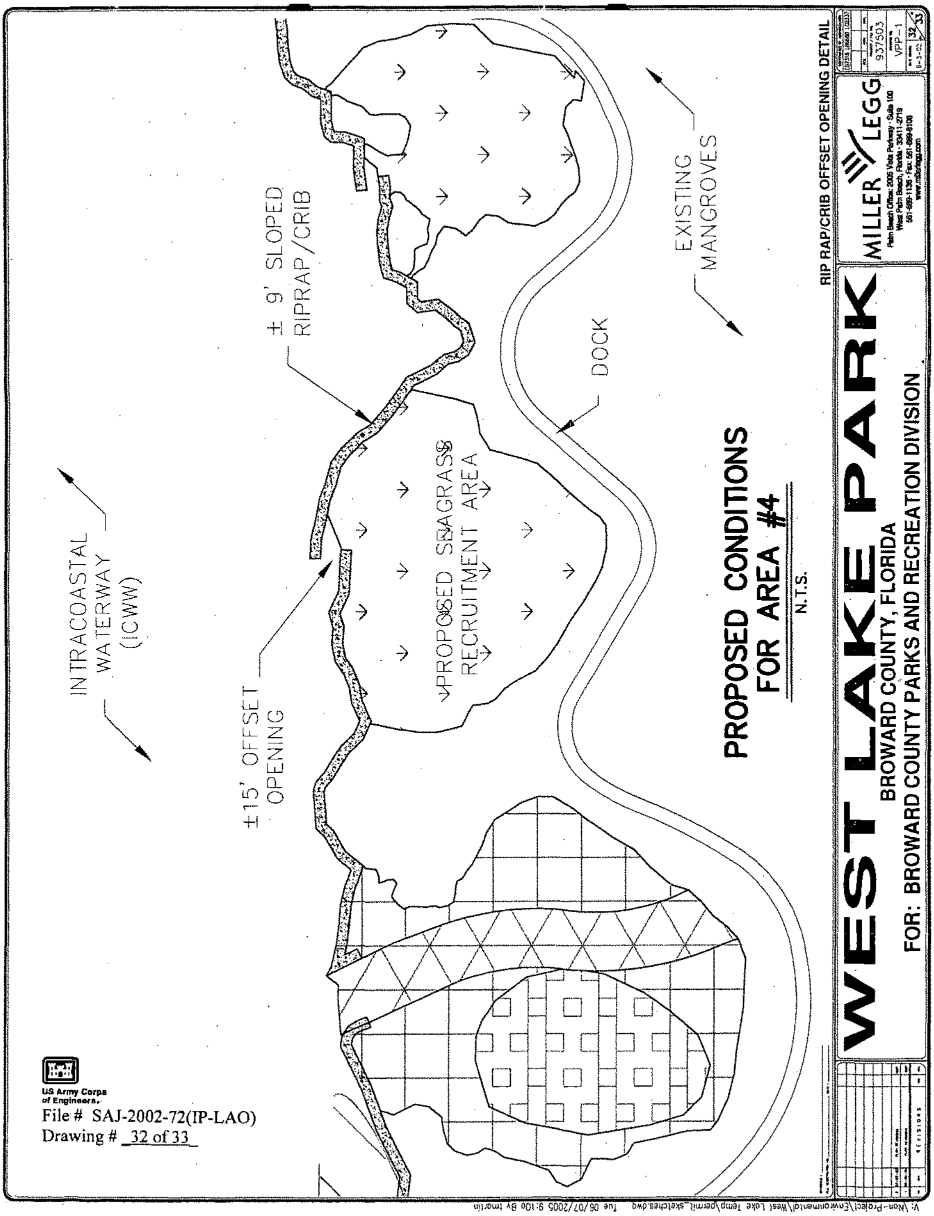
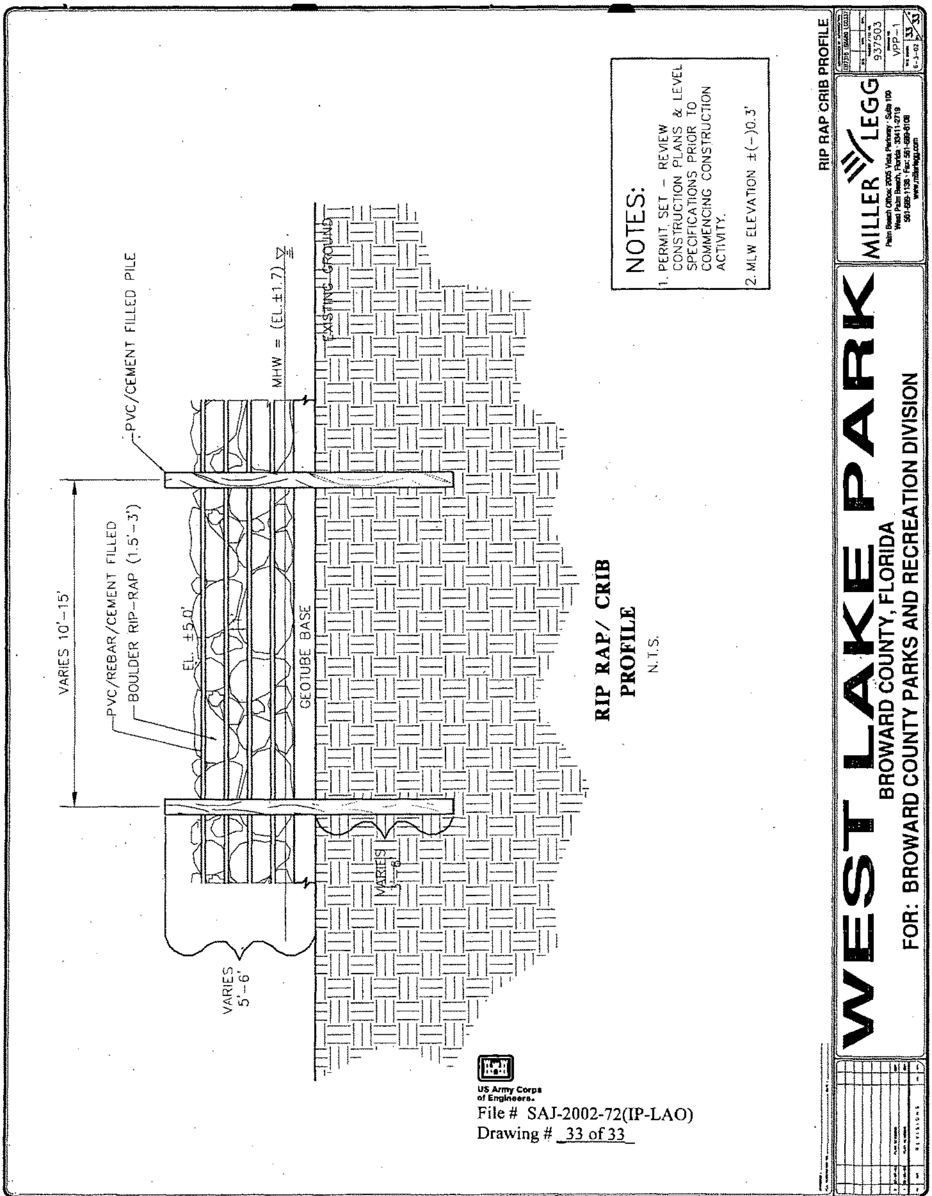
Drawing # 311 of 33


INTRACOASTAL WATERWAY (ICWW)
± 9' SLOPED RIPRAP/CRIB
±15' OFFSET OPENING
PROPOSED SEAGRASS RECRUITMENT AREA
DOCK
EXISTING MANGROVES
PROPOSED CONDITIONS FOR AREA #4
N.T.S.
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
RIP RAP/CRIB OFFSET OPENING DETAIL
MILLER LEGG
937503
VPP-1
32
33
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 32 of 33


PVC/CEMENT FILLED PILE
VARIES 10'-15'
PVC/REBAR/CEMENT FILLED
BOULDER RIP-RAP (1.5'-3')
EL. ±5.0'
GEOTUBE BASE
MHW = (EL.±1.7)
EXISTING GROUND
VARIES 5'-6'
VARIES 3'-6'
RIP RAP/ CRIB PROFILE
N.T.S.
NOTES:
1. PERMIT SET - REVIEW CONSTRUCTION PLANS & LEVEL SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY.
2. MLW ELEVATION ±(-)0.3'
US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 33 of 33
WEST LAKE PARK
BROWARD COUNTY, FLORIDA
FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION
MILLER LEGG
RIP RAP CRIB PROFILE
937503
VPP-1
33

US Army Corps of Engineers.
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ATTACHMENT 2 – page 1

SPECIAL CONDITIONS

1. The construction phase of this permit shall expire on April 15, 2009.

2. The permittee shall be responsible for the correction of any erosion, shoaling or water quality problems that result from the construction or operation of the surface water management system.

3. Measures shall be taken during construction to insure that sedimentation and/or turbidity violations do not occur in the receiving water.

4. The District reserves the right to require that additional water quality treatment methods be incorporated into the drainage system if such measures are shown to be necessary.

5. Facilities other than those stated herein shall not be constructed without an approved modification of this permit.

6. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the District may require the permittee to provide appropriate mitigation to the District or other impacted party. The District may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

7. All barge activity shall occur in areas where a minimum one-foot bottom clearance is maintained.

8. All contractors must be provided with a copy of the staff report and permit conditions prior to the commencement of construction. The permittee is responsible for ensuring that all contractors adhere to the project construction details and methods indicated on the attached permit Exhibits and described herein.

9. The successful completion of the mitigation plan is heavily dependent on proper site grading. Therefore, prior to demobilizing equipment from the site and prior to planting, the permittee shall schedule an inspection by District Environmental Resource Compliance staff to ensure that appropriate elevations and slopes have been achieved.

10. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or other surface waters prior to disposal in a suitable upland spoil disposal area.

11. Prior to the commencement of construction in or adjacent to wetlands and/or other surface waters, the perimeter of the mitigation construction area(s) shall be enclosed with stakedand trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas. The permittee shall notify the District's Environmental Resource Compliance staff in writing upon installation of the silt fencing and/or turbidity screens and schedule an inspection of this work. The silt fencing and/or turbidity screens shall be subject to District staff approval. The permittee shall modify the silt fencing/turbidity screens if District staff determines that it is insufficient or is not in conformance with the intent of this permit. The silt fencing and/or turbidity screens shall remain in place until all adjacent construction activities are complete.

12. All temporary wetland impacts associated with mitigation construction activities shall be restored to preexisting wetland conditions immediately following completion of the mitigation element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time zero mitigation monitoring report and shall be maintained and monitored in conjunction with the mitigation monitoring program provided for in the enclosed exhibits.

US Army Corps of Engineers

File # SAJ-2002-72(IP-LAO)
ATTACHMENT 2 – page 2

PERMIT NO: 06-04016-P
PAGE 3 OF 10

13. This permit only applies to authorization from the South Florida Water Management District; it is possible that additional permits may be necessary from other agencies. Nothing contained herein relieves the permittee from timely complying with applicable laws of other federal, state or local governments.

14. Manatee exclusion grates shall be placed across the openings of existing or proposed culverts or pipes that are greater than eighteen inches but smaller than six feet in diameter. The installation of grates applies to any submerged or partially submerged pipes and culverts accessible to manatees during any tidal phase. Permittee shall keep all grates free and clear of debris.

15. Endangered species, threatened species and/or species of special concern have been observed onsite and/or the project contains suitable habitat for these species. It shall be the permittee's responsibility to coordinate with the Florida Fish and Wildlife Conservation Commission and/or the U.S. Fish and Wildlife Service for appropriate guidance, recommendations and/or necessary permits to avoid impacts to listed species.

16. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (1-561-562-3909) in south Florida.

Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 81/2" by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. The U.S. Fish and Wildlife Service should also be contacted in Jacksonville (1-904-232-2580) for north Florida or in

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ATTACHMENT 2 – page 3

PERMIT NO: 06-04016-P
PAGE 4 OF 10

Vero Beach (1-561-562-3909) for south Florida.

17. Due to the proximity of this project to areas of known manatee concentrations, all work conducted waterward of the existing shoreline during the months of December, January and February shall be subject to the following conditions:

a) The Bureau of Protected Species Management shall be notified one week prior to the commencement of the work;

b) at least one person shall be designated as a manatee observer at each site when in-water work is being performed. the manatee observer must be on site during all in-water construction activities and will advise personnel to cease operation upon sighting a manatee within 50 feet of any in-water construction activity. Movement of a work barge, other associated vessels, or any in-water work shall not be performed after sunset, when the possibility of spotting manatees is negligible; and

c) the permittee shall ensure that the contractor maintains a log detailing sightings, collisions, or injuries to manatees should they occur during the contract period. Following project completion, the logs shall be submitted to the Bureau of Protected Species Management, 620 South Meridian Street, Tallahassee, Florida 32399-1600;

18. The following exhibits for the permit are incorporated by reference herein and are located in the permit file:

Exhibit No. 14 List of Outparcels within West Lake Natural Preserve and Recreation Area, dated 12/19/01
Exhibit No. 17 Sublease Agreement for West Lake Park, between FDNR and Broward County, executed 12/22/88
Exhibit No. 18 Management Plan for West Lake Park, by Broward County Parks and Recreation Division
Exhibit No. 19 Management Plan Update for West Lake Park, authorized by FDEP on 2/7/02

19. No construction is authorized on land that the permittee does not own until the permittee acquires title to such land.

20. This permit does not eliminate the need to obtain any and all necessary easements and rights of way prior to the start of any activity approved herein. This permit does not convey to the permittee, or create for the permittee, any property right, or any interest in real property; nor does it authorize any entrance upon, or activities on, property which is not owned or controlled by the permittee; or convey any rights or privileges other than those specified in the permit and Chapter 40E-4 or Chapter 40E-40, F.A.C..

21. As provided in Exhibit No. 10, Broward County Parks and Recreation Division shall be responsible for the mitigation construction, five year maintenance and monitoring and perpetual management of the proposed mitigation efforts at West Lake Park.

22. Perpetual maintenance of the mitigation area shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

23. The use of the mitigation units from this project shall be limited to projects undertaken by Broward County. Generally, the mitigation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater and/or estuarine wetland communities. The suitability of this mitigation area to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

The amount of potential credit generated by the mitigation efforts has been determined using the Uniform Mitigation Assessment Method, 62-345, FAC (UMAM) through an assessment conducted jointly by District and Broward County Department of Planning and Environmental Protection staff and the applicant's representatives and is reflected in the UMAM worksheets provided in Exhibit No. 22. Use of the mitigation credits shall be addressed at the time of application for the wetland impact projects.

24. At the time of application for any that includes wetland impacts and proposes to use mitigation credit from this West Lake mitigation plan, the permittee shall demonstrate that an adequate portion of the mitigation plan has been or shall be executed and completed in a timely manner (i.e., concurrent with the wetland impacts) and that the specified mitigation will adequately offset the wetland impacts associated with that construction project.

25. A mitigation program for West Lake Park shall be implemented in accordance with the enclosed exhibits. The permittee shall create 51.7 acres of wetlands, restore 5.5 acres of wetlands, restore 13.4 acres of uplands, enhance 50.4 acres of wetlands, and preserve 53.3 acres of wetlands.

26. The District reserves the right to require remedial measures to be taken by the permittee if monitoring or other information demonstrates that adverse impacts to onsite or offsite wetlands, upland conservation areas or buffers, or other surface waters have occurred due to project related activities.

27. A mitigation monitoring program shall be implemented in accordance with the enclosed exhibits to ensure that the targeted success criteria are met. The monitoring program shall extend for a period of 5 years with annual reports submitted to District Environmental Resource Compliance staff. The permittee shall be responsible for ensuring that the mitigation areas described herein meet the specified percent coverage and/or survivorship of planted and/or recruited vegetation throughout the duration of the monitoring program, with replanting as necessary. If native wetland, transitional, and upland species do not achieve the specified percent coverage and/or survivorship at any time during the monitoring program, native species shall be planted in accordance with the maintenance program. At the end of the 5 year monitoring program the entire mitigation area shall contain an 80% survival of planted vegetation and an 80% coverage of desirable plant species suitable for that mitigation area.

28. A maintenance program shall be implemented in accordance with Exhibit Nos. 4 and 7 for the mitigation areas on a regular basis to ensure the integrity and viability of those areas as permitted. Maintenance shall be conducted in perpetuity to ensure that the conservation area is maintained free from Category 1 exotic vegetation (as defined by the Florida Exotic Pest Plant Council at the time of permit issuance) immediately following a maintenance activity. Coverage of exotic and nuisance plant species shall not exceed 5% of total cover between maintenance activities. In addition, the permittee shall manage the conservation areas such that exotic/nuisance plant species do not dominate any one section of those areas.

29. A time zero monitoring report for the West Lake Park mitigation project shall be conducted in accordance with Exhibit Nos. 4 and 7 for all completed mitigation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

30. The permittee shall comply with applicable state water quality standards including:
a) 62-302.500 - Minimum criteria for all surface waters at all places and all times;
b) 62-302.510 - Surface waters: general criteria
c) 62-302.560 - Class III waters; recreation, propagation and maintenance of a healthy, well balanced population of fish and wildlife;
d) 62-302.600 - Classified waters.

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ATTACHMENT 2 – page 5

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31. A turbidity control plan shall be implemented in accordance with Exhibit Nos. 4 and 7. Prior to the commencement of construction in or adjacent to the Intracoastal Waterway or other surface water bodies within West Lake Park, floating turbidity curtains with weighted skirts that extend to the submerged bottom shall be properly installed to isolate adjacent waters from the work area. The floating turbidity curtains shall be maintained and shall remain in place until all construction is complete and turbidity levels in the project area are within 29 NTUs of background levels. The permittee shall be responsible for ensuring that turbidity control devices are inspected daily and maintained in good working order so that there are no violations of state water quality standards outside of the turbidity screens.

32. A water quality monitoring program shall be implemented in accordance with Exhibit No. 4 and as outlined below:

Turbidity expressed in nephelometric turbidity units (ntu). Background samples shall be taken 200 feet upstream of any construction activity within adjacent surface waters Samples shall also be taken 200 feet downstream. Samples shall be taken at least twice daily, with at least a four-hour interval, during all work authorized by this permit involving spoil removal, grading or other forms of earthwork that may generate turbidity in other surface waters.

Monitoring shall begin on the first day of construction for all activities within or adjacent to surface waters. Monitoring shall cease when all construction activities are completed. The monitoring data must demonstrate that turbidity 200 feet downstream of all proposed activities is less than or equal to 29 NTU's above natural background turbidity (or meets OFW standards) and 200 feet upstream of each proposed activity for a period of 7 consecutive days after completion of construction. If monitoring shows such levels to be exceeded, construction shall cease and District compliance staff shall be notified immediately. Work shall not resume until District staff is satisfied that adequate corrective measures have been taken and turbidity has returned to acceptable levels.

All monitoring data shall be maintained on site and be available to District staff during regular business hours. The content of the data shall include:

1) permit and application number; (2) dates of sampling and analysis; (3) statement describing the methods used in collection, handling, storage and analysis of the samples; (4) a map indicating the sampling locations and (5) a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, limits of detection and accuracy of the data.

Monitoring reports shall also include the following information for each sample that is taken:
(a) time of day samples taken;
(b) depth of water body;
(c) depth of samples;
(d) antecedent weather conditions;
(e) wind direction and velocity;

33. Documentation of ownership of the Priority 1 outparcels by the County identified in Exhibit Nos. 14 and 15 must be provided to the District in order to be credited as mitigation for preservation credit and before any other mitigation element is constructed which relies on those outparcels for their construction, access or other purposes.

34. Those portions of the park which are under County ownership and where mitigation is proposed that have been determined to potentially be vulnerable to subsequent alteration (refer to Exhibit No. 13) shall be placed under a conservation easement dedicated to the District. A draft conservation easement document along with boundary surveys and legal descriptions for the identified areas to be protected under the conservation easement shall be submitted for review by District staff and, upon their approval, shall be recorded in County records before mitigation credit for those areas may be used as compensation to offset wetland impacts associated

with other County projects.

35. Management items outlined in Exhibit No. 5 and described in Exhibit Nos. 4 and 7 may be later considered for mitigation credit through a modification of this permit if supporting information to justify mitigation credit for items has been sufficiently demonstrated to the District.

36. Any mitigation credit generated by the planned mitigation activities described herein shall only be eligible for use as compensation to offset tidal, saltwater or estuarine wetland impacts associated with projects proposed by Broward County. Use of such mitigation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the mitigation credit.

37. Early transplanting of seagrass from the impact site to the proposed seagrass creation areas shall be voluntary and shall not be subject to survival criteria. However, the recruitment and coverage criteria specified in this permit shall apply.

38. No modifications to this permit shall be required for construction methodology variations from those described in Exhibit No. 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that District staff concur with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by District regulatory and/or compliance staff.

39. Select mangrove trimming necessary to accomplish the planned mitigation efforts described herein shall be authorized by this permit.

40. Mitigation credit for the designated manatee protection areas shall be granted only after documentation of an agreement, easement or other necessary form of authorization for installation of the manatee protection barriers from the U.S. Army Corps of Engineers has been submitted to the District.

41. Activities associated with the implementation of the mitigation, monitoring and maintenance plan(s) shall be completed in accordance with the work schedule attached as Exhibit No. 21. Any deviation from these time frames will require prior approval from the District's Environmental Resource Compliance staff. Such requests must be made in writing and shall include (1) reason for the change, (2) proposed start/finish and/or completion dates; and (3) progress report on the status of the project development or mitigation effort.

STANDARD MANATEE CONDITIONS FOR IN-WATER WORK
July 2005

The Permittee shall comply with the following conditions intended to protect manatees from direct project effects:

a. All personnel associated with the project shall be instructed about the presence of manatees and manatee speed zones, and the need to avoid collisions with and injury to manatees. The Permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act, the Endangered Species Act, and the Florida Manatee Sanctuary Act.

b. All vessels associated with the construction project shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

c. Siltation or turbidity barriers shall be made of material in which manatees can not become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.

d. All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, must be shutdown if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.

e. Any collision with or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (1-561-562-3909) for south Florida.

f. Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the Permittee upon completion of the project. Awareness signs that have already been approved for this use by the Florida Fish and Wildlife Conservation Commission (FWC) must be used. One sign measuring at least 3 ft. by 4 ft., which reads *Caution: Manatee Area* must be posted. A second sign measuring at least 81/2" by 11" explaining the requirements for "Idle Speed/No Wake" and the shut down of in-water operations must be posted in a location prominently visible to all personnel engaged in water-related activities.

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ATTACHMENT 3

CAUTION: MANATEE HABITAT

All project vessels

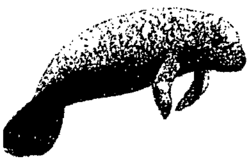
IDLE SPEED / NO WAKE

When a manatee is within 50 feet of work
all in-water activities must

SHUT DOWN

Report any collision or injury to :
1-888-404-FWCC (1-888-404-3922)

Florida Fish and Wildlife Conservation Commission



Permanent Manatee Sign Information

(Revised June 2001)

There are two types of approved permanent manatee signs that may be required by permit or lease: educational signs and awareness signs (see page 2 for detailed descriptions). These educational signs are non-regulatory in nature.

The permit/lease holder should forward a project site plan to the Bureau of Protected Species Management (620 South Meridian Street, OES-BPS, Tallahassee, FL 32399-1600) with the type, number, and location of signs indicated on the site plan. The applicant should also include a location map of the facility in relation to waterways, a county location map, and the permit and/or lease number associated with the project. BPSM will review the sign placement proposed for the project and notify the applicant within 30 days of receiving the plan if the signs and locations are unacceptable. Correspondence may be sent to offer suggestions on the type, number, and location of the signs. If the applicant has not received a response within 30 days, the proposed signs and their locations should be considered approved. Letters indicating approval of a sign site plan are available upon request.

The educational signs must be placed in a prominent location for maximum visibility, such as near walkways, dockmaster offices, restrooms, or foot traffic access points to piers/docks. The awareness signs should be placed facing land on walkways or docks. Permanent manatee signs should not be installed on pilings in the water nor be attached to navigational markers. If a facility has multiple docks with separate walkways, signs should be installed near each walkway or dock. These signs should be oriented so that boaters using the facility will be reminded of the presence of manatees. The signs are not required to be in view of the general boating public. If approved signs and their locations are found to be out of accordance with these guidelines, the permit/lease holder will have to relocate or install additional signs.

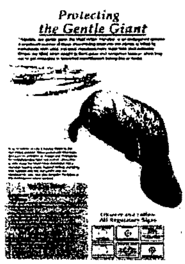
The following specifications should only be considered guidelines for typical projects. Project locations near manatee important habitat, or involving other special circumstances may warrant additional signs.

Facility (wet, dry, temporary, or permanent)	**Recommended Signs**
Residential with less than 10 slips	• Site by site determination required
Boat ramps, charters or cruises, boat rental or restaurant facilities	• Educational Signs • Awareness Signs (may require multiple signs - site by site determination for quantity)
Facilities with greater than 10 slips	• Educational Signs (may require multiple signs - site by site determination for quantity) • Awareness Signs (may require multiple signs - site by site determination for quantity)

Manatee Awareness Sign

The "**Caution: Manatee Area**" sign is 3' by 4' and is available from all of the companies listed on the sign supplier list. These caution signs are intended to remind boaters using the facility of the presence of manatees while on the water. This sign will meet the manatee awareness display condition required by lease/permit.

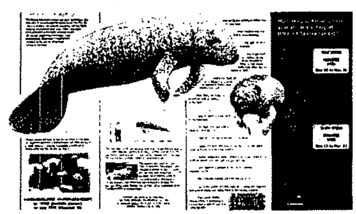
Manatee Educational Signs



These signs are 2' by 3' and are available only through Wilderness Graphics. "**Protecting the Gentle Giant**" lists the potential threats to manatees and what the public can do to help protect them. "**The Florida Manatee**" provides a general description of manatees and their behavior. These two signs must be displayed as a pair to meet the manatee educational display condition required by lease/permit.

The "**Manatee Basics for Boaters**" sign is 3' by 4' and is available from all of the companies listed on the sign supplier list. This educational sign provides information on the characteristics of manatees and the potential threat to this endangered species from boat operation. This sign will meet the manatee educational display required by lease/permit.

Manatee Basics for Boaters



FWC Approved Manatee Educational Sign Suppliers

ASAP Signs & Designs
624-B Pinellas Street
Clearwater, FL 33756
Phone: (727) 443-4878
Fax: (727) 442-7573

Wilderness Graphics, Inc.
Box 1635
Tallahassee, FL 32302
Phone: (850) 224-6414
Fax: (850) 561-3943
www.wildernessqraphics.com

Cape Coral Signs & Designs
1311 Del Prado Boulevard
Cape Coral, FL 33990
Phone: (239) 772-9992
Fax: (239) 772-3848

Municipal Supply & Sign Co.
1095 Fifth Avenue, North
P. O. Box 1765
Naples, FL 33939-1765
Phone: (800) 329-5366 or
(239) 262-4639
Fax: (239) 262-4645
www.municiDalsiqns.com

Vital Signs
104615 Overseas Highway
Key Largo, FL 33037
Phone: (305) 451-5133
Fax: (305) 451-5163

Universal Signs & Accessories P. O.
2912 Orange Avenue
Ft. Pierce, FL 34947
Phone: (800) 432-0331 or
(772) 461-0665
Fax: (772) 461-0669

New City Signs
182928 Street North
St. Petersburg, FL 33713
Phone: (727) 323-7897
Fax: (727) 323-1897

United Rentals Highway Technologies
309 Angle Road
Ft. Pierce, FL 34947
Phone: (772) 489-8772 or
(800) 489-8758 (FL only)
Fax: (772) 489-8757

BROWARD COUNTY
FLORIDA

PARKS AND RECREATION DIVISION
950 N.W. 38TH Street • Oakland Park, Florida 33309-5982 • 954-357-8100 • TTY 954-537-2844 • FAX 954-537-2849
Winner of the National Gold Medal Award for Excellence in Park and Recreation Management
Accredited by the Commission for Accreditation of Parks and Recreation Agencies (CAPRA)

May 28, 2002

Dylan Larson, P.W.S.
Miller, Legg & Associates, Inc.
1800 N. Douglas Road, Suite 200
Pembroke Pines, FL 33024-3200

Re: Master Mitigation for West Lake Park
RLI #021899-RB
BCPRD #425-00A, MLA #937503

Dear Mr. Larson:

The purpose of this letter is to acknowledge responsibility for mitigation construction, five year maintenance and monitoring, and perpetual management of the overall mitigation efforts underway at West Lake Park.

As previously discussed with you, the published Request for Letters of Interest and our subsequent Agreement with Miller, Legg & Associates, Inc. both state that the consultant shall be responsible for construction administration and overseeing the monitoring and maintenance for the required warranty period. Therefore, Miller, Legg & Associates, Inc. will be responsible for these activities acting as agent for Broward County. Broward County Parks and Recreation Division will be responsible for overseeing your project activities and for the perpetual management after the warranty period expires.

If you have any questions, please contact me at (954) 357-8181.

Sincerely,

Pat Young

Pat Young
Administrative Manager

PY:pay

US Army Corps of Engineers
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ATTACHMENT 4

a:\5 yr monitor.wpd

West Lake Park

Mitigation Plan

Prepared for:
Broward County Parks and Recreation Division
950 N.W. 38th Street
Oakland Park, FL 33309

Prepared by:

Miller, Legg & Associates, Inc.
1800 N. Douglas Road, Suite 200
Pembroke Pines, FL 33024-3200

November 25, 2003

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of Engineers.
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1.0 PREAMBLE

West Lake Park is a ±1,522 acre park in Sections 25, 35, and 36 in Township 50S, Range 42E and Sections 1, 2, 11, and 12 in Township 51S, Range 42E in Broward County Florida. The Park is currently managed by Broward County Parks and Recreation Division (BCPRD). The Park includes mangrove, seagrass, mud flat, upland, open water communities and community recreation facilities. The Park also currently contains ±65.3 acres of exotic plant-dominated spoil islands and uplands.

The development of the West Lake Park Mitigation Plan is a continuation of the previously successful mitigation efforts at West Lake Park. This plan is intended to address ecosystem-level improvements through a comprehensive plan for the entire West Lake region and the surrounding environment. The improvements are intended to allow the ecosystem to function as naturally as possible with minimal human influence.

Restoration and enhancement of tidal wetland functions and associated benefits to significant wildlife species should occur through the implementation of 12 key mitigation components with a focus on exotic upland spoil/vegetation removal and hydrologic flushing improvements. These key ecological improvement concepts envisioned include:

- Exotic vegetation removal,
- Creation of mangroves, mudflats, channels, tidal pools, seagrass recruitment areas, and native upland hammocks from exotic-infested spoil areas,
- Shoreline protection along the Intracoastal Waterway (ICWW) and Dania Cutoff Canal,
- Improvement of flushing and circulation within the Dania Salt Marsh by the creation of a north-south flushing channel and removing hindrances to water movement,
- Outparcel acquisition,
- Improvements to Park flushing throughout West Lake Park, either through installation of culverts, upsizing, or desilting existing culverts to enhance and restore water flow within the Park,
- Protection of established bird nesting, feeding, and watering area,
- Installation of additional osprey nesting platforms,
- Establishment of two manatee protection areas along the ICWW,
- Desilting specific existing channels,
- Creation of a crocodile basking area away from current development
- Removal of existing barges from Whiskey Creek.

1.1 Project Description

West Lake Park contains habitats that are significantly imperiled in the South Florida region. The estuarine wetlands and upland upland hammocks historically located on top and east of the Southeast Ridge within Broward County have been mostly lost due to development. Due to its location and size, West Lake Park provides a vista of Broward

County's historic mangrove environment. This important natural area provides wildlife resources, upland recreational possibilities, and sensitive wetland estuarine habitat.

Implementation of the West Lake Park Mitigation Plan should result in identifiable ecological benefits to the Park and the surrounding watershed. These benefits include:

- Removal of ±80 acres of exotic vegetation and resulting seed source that degrades the natural communities in this and adjacent areas,
- Increasing habitat diversity in the Park,
- Protecting the shoreline from continued erosion due to wave energy and storm events,
- Increasing the carrying capacity of fisheries in the Dania Salt Marsh,
- Acquiring outparcels will bring the land under clear public ownership to preserve and protect the property in perpetuity,
- Reducing the threat of predation on birds using the bird nesting area,
- Increasing the potential for nesting success for ospreys in Broward County,
- Protection of the West Indian Manatee and submerged natural resources,
- Reducing turbidity in the Park,
- Creating an alternative crocodile habitat in a more isolated location,
- Increasing areas for seagrass recruitment,
- Shoreline stabilization, reduction of sediment contribution, and increased floral diversity.

1.2 Goals

The goals of the West Lake Park Mitigation Plan are as follows:

- To establish and enhance a large unified mitigation area that provides a diverse estuarine wetland system of high quality. This will encourage propagation of desirable invertebrates and additional use by birds, fish, amphibians, reptiles, and mammals.
- To remove exotic and invasive plant species and recruit desirable flora to provide valuable habitat for wildlife.
- To attain a minimum of 80% survivorship of planted species, and 80% coverage of desirable plant species in the mitigation creation areas.
- To attain a mitigation system that includes functional wetlands and uplands that benefit both wildlife and the surrounding community.

1.3 Existing Conditions

West Lake Park currently consists of approximately 990.5 acres of mangrove swamps, ±246.9 acres of lakes, ±65.3 acres of exotic plant-dominated spoil areas, and ±221.7 acres of other habitats, including waterways, saltwater marsh, tidal flats, barren land, seagrass, and roads and highways. The Park is tidally influenced by direct connection to the

ICWW on the east and the Dania Cutoff Canal to the north. The Park is sectioned by Sheridan Street and Dania Beach Boulevard, dividing the Park into three areas.

Hydrologic and Water Quality Conditions

West Lake Park is tidally influenced through direct connection and through numerous channels that connect the interior of the Park to the ICWW. The tidal cycle in Florida is semi-diurnal, that is, two high and low tides each day. Freshwater inputs are mainly limited to stormwater runoff and direct rainfall. In the Dania Salt Marsh, a maintenance road and remnant berms limit tidal flow.

In addition, an extensive canal system is present in the western half of the Park. Approximately 12 miles of channels were historically created when the area was in agricultural operations back in the 1950s, however, some of them are nearly silted-in and, therefore, provide limited flushing. These canals provide a collection and channeling system for rainwater and also provide a system for tidal flushing of surface water. Both functions are necessary to provide optimum conditions for brackish water estuaries vital to development of nurseries for fishes such as the snook (*Centropomus undecimalis*) and tarpon (*Megalops atlanticus*) and serve as foraging areas for wading birds.

Water quality was analyzed at 10 stations throughout West Lake Park to establish baseline water quality data. Water levels were recorded at Stations 1-8 using RDS WL80 Automated Well Piezometers.

Water quality parameters were collected thirteen times and water levels were recorded hourly between June 21 and December 11, 2000. The placement of the piezometers was designed to measure tidal flow rates running north-south through the Park and east-west between the ICWW and the interior of West Lake and to determine Mean High Water (MHW) and Mean Low Water (MLW) elevations (in feet NGVD) at various locations throughout the Park. This information was used to determine proper elevations for construction of proposed mud flats, mangrove islands, flushing channels, etc.

Vegetative Community Types

The dominant vegetative community is the mangrove swamp; approximately 990 acres of mangroves exist within the Park. Red mangroves (*Rhizophora mangle*), black mangroves (*Avicennia germinans*), and white mangroves (*Laguncularia racemosa*) are abundant. Buttonwood (*Conocarpus erectus*) and sea oxeye daisy (*Borrichia* spp.) are also present within the Park to the lesser extent.

Various other native species are present at Anne Kolb Nature Center and the recreational portion of the Park (south of Sheridan Street). These species include gumbo limbo (*Bursera simaruba*), cabbage palm (*Sabal palmetto*), pigeon plum (*Coccoloba diversifolia*), sea grape (*Coccoloba uvifera*), and blolly (*Guapira discolor*).

Approximately 80 acres of Australian pine (*Casuarina equisetifolia*) and other exotic vegetation exist throughout the Park. Of those 80 acres, approximately 40 acres of these Australian pine dominated areas are along the ICWW and exist on spoil islands created during the historical dredging of the ICWW. The remaining 40 acres are scattered inland throughout the Park. These exotic plant-dominated areas are targeted for conversion to desirable native vegetative communities.

2.0 ESTABLISHMENT OF WEST LAKE PARK MITIGATION IMPROVEMENTS

The proposed improvements at West Lake Park are designed to improve the functional values of the estuarine wetlands within the Park and have been divided into nine phases:

1) Dania Cutoff Canal to Dania Beach Boulevard
2) Dania Beach Boulevard to Anne Kolb Nature Center,
3) Anne Kolb Nature Center to Bird Nesting Area,
4) Bird Nesting Area to South End of Park,
5) West Lake Park Recreational Area/Sheridan Street,
6) Dania Salt Marsh,
7) Exotic Vegetation Eradication,
8) Dania Cutoff Canal,
9) Outparcel Acquisition

These phases were divided based on geographic location, i.e. all improvements in each phase are located within the same general area (refer to attached phasing map). The only exceptions are for Phases 7 and 9 (exotic vegetation eradication and outparcel acquisition are park-wide phases).

2.1 Phase 1 – Dania Cut-off Canal to Dania Beach Boulevard

This phase includes the installation of new culverts to increase flushing, the creation of a manatee protection area along the ICWW, the creation of mangrove, seagrass, mudflat, and channel areas from exotic plant-dominated spoil areas, and installation of shoreline protection.

Flushing Improvements

Four culverts are proposed to be installed north of Dania Beach Blvd. to allow greater surface water exchange between areas of the Park. Insufficient water exchange can lead to stunted mangroves, stagnant water/low water quality, limited fisheries usage, and increased siltation.

Manatee Protection Areas

The West Indian manatee or sea cow (*Trichechus manatus*) is a large, herbivorous, aquatic mammal that uses a variety of habitats such as shallow coastal waters, rivers, and springs in Florida. This species is endangered throughout its range. A low reproductive rate, combined with loss of habitat and high rates of mortality, often from human-related causes such as boats and watercraft, threaten its future. This species is the focus of a wide range of protection efforts by federal, state, and local agencies. In addition universities, corporations, and non-profit conservation organizations are supporting efforts to protect these animals.

Based on information from the Management Plan for West Lake and personal observations, the manatees are occasionally seen in the shallow waters of West Lake Park, and are regularly observed in the Intracoastal Waterway, Whiskey Creek, and the Dania Cutoff Canal adjacent to West Lake Park. These waters, except for the interior lakes, are heavily traveled by boats/personal watercraft.

Boat-related mortality is probably the greatest single threat to the manatee. Regulation of boat speeds and boat exclusion areas are being enforced to reduce boat-related injuries and harassment. The effect of boats on manatee populations is particularly critical because it is mostly adults that are killed. Manatees must maintain a high adult survivorship due to their low reproductive rates to keep populations stable. In Whiskey Creek and the cove area south of Dania Beach Blvd., there is minimal protection for the manatee from boat traffic. However, manatees regularly travel through the main channel of the Intracoastal Waterway and the Whiskey Creek area and must contend with heavy boat and barge traffic.

Manatee/seagrass protection areas (MPAs) are proposed to be established in Whiskey Creek, the southern end of the Creek, and at the Cove area south of Dania Beach Blvd. The MPAs will be designated using appropriate signage and floating barrel lines that would prohibit boats and personal watercraft from entering the protected area while still allowing manatees, fishes, and other fauna to pass.

The primary benefit is a safe retreat for manatees in areas of high boat traffic. Another benefit is the protection of seagrass beds, a known source of food for manatees, from prop scars and turbid conditions caused by boats/personal watercraft wakes. Without these barriers, manatees will remain at risk of injury within these heavily traveled areas.

Creation of Mangrove Mudflat, Seagrass, and Channels from Spoil Areas

Exotic plant-dominated upland spoil areas in this area will be replaced by extensive wetland creation areas following practices used successfully on previous projects within West Lake Park. Exotic plant-dominated uplands will be converted into desirable, native communities including mangroves, mud flats, tidal pools, seagrass beds, and native upland hammocks to encourage usage by a diversity of plant and animal species.

Mangrove Creation Areas. Mangroves provide physical habitat for many species of plants and animals that could not survive alone in the intertidal zone. Mangrove systems contain a highly complex food web, with many organisms dependent upon one another for their survival. In addition, mangrove areas function as nurseries for a wide variety of recreationally and commercially important fish species, including snook, tarpon, and snapper. Upland areas infested with exotic vegetation will be cleared and scraped down to the proper elevation to support natural recruitment of mangroves. If necessary, these areas may also receive supplemental mangrove plantings to promote their spread and establishment (refer to the permit sketches for details).

Mud Flat/Tidal Pool Creation Areas. Mud flats are important to shorebirds, allowing them to feed on prey stranded on and in the exposed surface of the tidal pools. Certain exotic plant infested uplands will be cleared and scraped down to serve as mud flats and tidal pools. Based on the current wildlife usage of the existing mud flats/tidal pools within West Lake Park, these proposed areas should serve as habitat for numerous invertebrates and provide new foraging areas for wetland dependent bird species (e.g., ibis, wood stork, herons, spoonbills, sandpipers, and knots). An osprey platform will be installed at the edge of the mud flat/tidal pool to provide a perching and nesting location. (Refer to the permit sketches for details).

Seagrass Creation Areas. Seagrass beds rank among the most productive ecosystems. Certain upland areas infested with exotic vegetation will be cleared and scraped down to serve as natural recruitment areas for seagrasses. An extensive survey revealed that seagrasses were present nearly the entire length of the ICWW's western half adjacent to West Lake Park (MLA, 2002). The dominant seagrass was paddle grass (*Halophila decipiens*). Johnson's seagrass (*Halophila johnsonii*), a threatened species, and shoal grass (*Halodule wrightii*) were also present. These seagrasses were present as patchy beds of varying density, usually with rubble and overgrowing algae interspersed. The seagrass areas will be specifically created from existing spoil islands along the ICWW adjacent to existing, dense seagrass beds. A sediment analysis was performed, and it was determined that the sediment in the spoil areas was similar to the sediment in the ICWW currently supporting seagrasses (Tierra, 2002).

Shoreline Protection – Riprap/Crib

The purpose of shoreline protection is to halt the constant erosion occurring along the ICWW caused by many factors such as boat traffic and storms. A shoreline regression analysis estimated the shoreline has eroded at a rate of ±1.5' per year. The placement of shoreline protection options are proposed to reduce further erosion of this shoreline and the mangrove population.

Based on a detailed shoreline analysis for the entire length of West Lake Park:

a) 15% of the shoreline does not require any stabilization (channel openings, bridge right-of-way, etc.)
b) shoreline protection could be placed along approximately 35% of the shoreline without incurring mangrove impacts,
c) an additional intermittent 15% of the shoreline may have room for narrow shoreline protection
d) the remaining 35% of the shoreline has virtually no separation between mangroves and seagrasses. The table below summarizes this information.

Note that this shoreline length is based on the limits from the mangroves on the north side of the channel by Holland Park northward to existing riprap ±1,200 ft. south of the Dania Cut-off Canal.

1) Cove (no protection needed)	±	997	linear feet	5%
Road Right-of-Way (no protection needed)	±	401	linear feet	2%
Channel openings (no protection needed)	±	952	linear feet	5%
Revetment on side of maintenance road	±	654	linear feet	3%
2) 7' to 15' width for shoreline protection *	±	6,744	linear feet	35%
3) ≥ 5' to ± <7' width for shoreline protection *	±	2,855	linear feet	15%
4) 0 to < 5' for shoreline protection *	±	6,582	linear feet	35%
Total Shoreline	±	19,185	linear feet	100%

* Separation between existing seagrasses and mangroves

The proposed riprap/crib structure will have a footprint of approximately 5 feet in width and will be constructed of vertical pilings with horizontal reinforcing bars, creating a crib. Riprap boulders (1' to 3' diameter) will be placed inside the crib. The base of the structure will be a geotube or equivalent stabilization. (Refer to the permit sketches for details). This will allow construction to occur without the use of a large barge and/or other heavy equipment.

Shoreline Protection – Enhance Existing Riprap

Supplemental riprap will be placed onto existing riprap along the ICWW from the Dania Cutoff Canal southward approximately ±1,500'. This riprap will most likely be placed from a shallow-draft barge with hand guidance. Because the riprap is being placed on already existing, but poorly functioning, riprap, primary and secondary impacts are not anticipated.

2.2 Phase 2 – Dania Beach Boulevard to Anne Kolb Nature Center

This phase includes the creation of a manatee protection area along the ICWW, the creation of mangrove, seagrass, mudflat, channels and upland hammock from exotic plant-dominated spoil areas, and installation of shoreline protection.

Upland hammock Creation Areas. Certain exotic plant infested uplands will be cleared and planted with native upland hammock floral species to create an alternative habitat to the surrounding wetlands. These upland hammock areas are intended to be used by faunal species for shelter, nesting/denning, and foraging. Reestablishment of upland hammocks will add new habitat opportunities for faunal species. These hammocks, minimally at West Lake Park, will add diversity and complexity to the Park's habitats. (Refer to the permit sketches for details).

A detailed description for the mangrove, mudflat/tidal pool, and channel improvements in this phase is discussed above in Section 2.1.

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2.3 *Phase 3 – Anne Kolb Nature Center to Bird Nesting Area*

This phase includes the installation of new culverts to increase flushing, the creation of mangrove, seagrass, mudflat/tidal pool, upland hammock, and channel areas from exotic plant-dominated spoil areas, and installation of shoreline protection. A detailed description for each type of improvement in this phase is discussed above in Section 2.1 and 2.2.

2.4 *Phase 4 – Bird Nesting Area to South End of Park*

This phase includes the installation of new culverts to increase flushing, the creation of mangrove, mudflat, channels, and upland hammock from exotic plant-dominated spoil areas, and installation of shoreline protection. A detailed description for each type of improvement in this phase is discussed above in Section 2.1 and 2.2.

2.5 *Phase 5 – West Lake Recreational Park/Sheridan Street*

This phase includes the installation of new culverts to increase flushing, the creation of mangrove, mudflat, channel, and upland hammock areas from exotic plant-dominated spoil areas, and installation of shoreline protection. A detailed description for each type of improvement in this phase is discussed above in Section 2.1.

2.6 *Phase 6 – Dania Salt Marsh*

The Dania Salt Marsh (DSM) was originally a freshwater marsh system prepared for agricultural purposes approximately 100 years ago (BCPRD, 1998). At that time, the marsh was channeled for irrigation and the fields planted with tomatoes. Subsequent to those events, Joseph Young, a Hollywood developer, purchased most of the land in this area and sold individual lots as part of a large-scale development plan for this area. Hurricanes and the Great Depression discouraged further development of the area at that time. The surrounding development, dredging of the ICWW, and drainage led to saltwater intrusion, which ended the tomato farming in this area during the 1950s. The conditions at the site encouraged the establishment of a salt marsh sea oxeye daisy (*Borrichia* spp.) habitat that has been evolving to a mangrove-dominated habitat in recent years.

Based on previous fisheries studies (Mangrove Systems, Inc. 1983, Lewis Environmental Services 1994; Roberts, 1994), and County staff observations, the western portions of West Lake Park are an important nursery habitat for commercial, recreational, and threatened fish species such as snook (*Centropomus undecimalis*), tarpon (*Megalops atlanticus*), mangrove snapper (*Lutjanus griseus*), and mangrove rivulus (*Rivulus marmoratus*) - listed as a Species of Special Concern by the Florida Fish and Wildlife Conservation Commission. The DSM has incurred physical changes throughout the years, that somewhat limit its function as a nursery habitat.

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Channel Improvements

Presently, portions of the primary channel (running east-west through the center of the salt marsh) contain surface water during both high and low tides. However, secondary channels contain minimal surface water during lower portions of the tidal cycle, thus limiting their availability to fish and other aquatic species.

This lack of surface water serves to limit the carrying capacity of fisheries within portions of the DSM. Without improvements to the salt marsh's hydrology, this area will continue to be underutilized by fish species when compared to its overall size.

Certain berms that run throughout the salt marsh are eroding with the resultant material filling in the smaller channels. In addition, this area received historic dumping of tires and debris, which also has had an effect on flushing and biological productivity.

Large fields of sea oxeye daisy (*Borrichia* spp.) became established within this area. The sea oxeye daisy portions of the salt marsh are being naturally displaced by mangrove (mainly white mangroves) and Brazilian pepper (*Schinus terebinthifolius*). Between 1980 and 2000, there was an 85% decrease of the sea oxeye daisy habitat within the DSM.

The proposed improvements for this area plan to be phased, beginning with the removal of blockages that hinder water movement in the existing primary channels. The effects of blockage removal will be monitored prior to proceeding with the other listed improvements.

One existing primary east-west channel near the center of the DSM will be cleared of material that now hinders water movement. This is intended to increase flushing and would increase the area of surface water coverage during low tide. This work would be performed in a manner as to minimize impacts to existing mangroves.

Four north-south channels will be created north of the FPL substation from spoil berms located between small secondary channels that filled in due to erosion of the spoil berm.

Channel/Mudflat Creation

The creation of a primary north-south flushing channel near the western boundary of West Lake Park will increase flushing and retain surface water during low tide in an area that is normally dry; this is intended to increase the amount of usable habitat for juvenile fish species. This work is proposed in the area of an historic haul road and dumpsite.

Certain secondary north-south channels will also be cleared of material that hinders water movement. This is intended to increase flushing and would increase the area of surface water coverage during low tide. This work is anticipated to be performed in a manner as to minimize impacts to existing mangrove trees with the assistance of a small suction dredge and a small backhoe.

The new channel will also create additional red mangrove habitat along both sides of the channel along the entire length.

The above habitat improvements to the salt marsh will benefit commercial, recreational, and threatened fisheries by increasing the area's carrying capacity for fishes, including snook, mangrove snapper, tarpon, and other important fishes.

Enhancement/protection of the Dania Salt Marsh will also allow for the protection of *Rivulus* sp., a Species of Special Concern, which has been documented by BCPRD to inhabit the Dania Salt Marsh.

The American crocodile (*Crocodylus acutus*) is an endangered reptile that averages 7'-11' in length. At least one crocodile is known to inhabit West Lake Park. This crocodile has been observed on numerous occasions basking near the Sheridan Ocean Club residential community adjacent to the west side of the Park. Currently there are limited areas within West Lake Park where a crocodile can bask. The creation of a basking area within the Dania Salt Marsh will provide this and other crocodiles with an additional secluded retreat, thereby reducing the possibility of disturbance.***2.7 Phase 7 – Exotic Vegetation Eradication***

Approximately 8.4 acres of exotic plant-dominated areas currently exist in isolated locations that are not targeted for other alterations. For these areas, exotic species will be treated and/or removed and native species allowed to revegetate.

2.8 Phase 8 – Riprap Relocation/Mangrove Creation along Dania Cutoff Canal

Presently, the northern boundary of West Lake Park extends waterward into the Dania Cutoff Canal (DCC). The existing riprap along the DCC would be moved north to the Park boundary. Approximately 2.0 acres of open water would then exist behind the riprap. These ±2.0 acres of open water will be filled using suitable material dredged from the spoil areas to the proper elevation to support natural recruitment of mangroves. If necessary, these areas may also receive supplemental mangrove plantings to promote their spread and establishment. (Refer to the permit sketches for details).

2.9 Phase 9 – Outparcel Acquisition

There are approximately 200 outparcels (±23 acres) that, if not acquired, would prevent the completion of some key proposed mitigation improvements.

The outparcels have been prioritized in order of importance (i.e., outparcels within a proposed improvement area have greater priority) to secure the land or vacate an encumbrance(s).

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3.0 POTENTIAL CONSTRUCTION ALTERNATIVES

This section describes environmentally sensitive construction alternatives and precautions that could be used during construction activities of this project. The contractor, however, will determine the appropriate alternative of construction based on the environmental constraints. The contractor shall provide protection, operate temporary facilities, and conduct construction in ways and that comply with environmental regulations, minimize the possibility that air, waterways, and subsoil may become contaminated or polluted, or result in other undesirable effects. While exact means and methods of the contractor cannot be dictated, the conceptual framework of guidelines discussed below would provide the appropriate restrictions.

Due to the environmental sensitivity of this project, the contractor and the appropriate subcontractors shall attend an environmental pre-construction meeting with appropriate owner and agency representatives. (Refer to the permit sketches and the attached phasing map for the locations of the improvements discussed herein).

3.1 Phase 1 – Dania Cut-off Canal to Dania Beach Boulevard

This phase includes the installation of new culverts to increase flushing, the creation of a manatee protection area along the ICWW, the creation of mangrove, seagrass, mudflat, and channel areas from exotic plant-dominated spoil areas #1-5, and installation of shoreline protection. The proposed improvements for this phase could be accessed using the existing maintenance road that connects to Dania Beach Blvd.; therefore, secondary impacts to adjacent resources are not anticipated. A suitable staging and stockpiling area for this phase exists just north of Dania Beach Blvd. and west of the ICWW along the existing maintenance road.

3.1.1 Spoil Area #1

Spoil Area #1 is targeted for conversion to a mangrove creation area. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).* Vegetation on the islands are proposed to be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation can access the spoil area using the existing maintenance road. Minor temporary impacts to mangroves (±0.03 acres) are anticipated to occur in order to widen the end of the maintenance road that will be used to access the spoil area.

To avoid and minimize impacts, the edge of the mangroves are proposed to be demarcated with visible fencing, where appropriate to protect mangroves from damage prior to clearing. In addition, exotic vegetation should be removed by non-mechanical means where mangroves and other natural vegetation is in close proximity to the exotic vegetation. The pile could be burned or removed by truck using the existing maintenance road and disposed of in an appropriate upland location in accordance with state and local regulations.

In order to provide turbidity control and containment, excavation of spoil material could proceed from the center of the spoil area outward. Material should be excavated using appropriate mechanical means, such as a small backhoe and/or bulldozer that can access the area using the existing maintenance road. Silt fencing/turbidity curtains shall be placed at the edge of mangroves after clearing of vegetation and shall remain until the end of construction in this area. The entire spoil area will be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment.

Spoil material may be used to 1) fill the geotubes discussed in Section 3.1.4, and/or 2) create the substrate for the ±2.0 acre mangrove creation area along the Dania Cutoff Canal that is discussed in Section 3.8 below. Excess spoil material may be removed from the site by dump trucks using the existing maintenance road. The contractor shall be responsible for placement of spoil on a suitable upland site to be used for public purposes unless otherwise appropriately addressed.

3.1.2 Spoil Areas #2 and #3

Spoil Areas #2 and #3 are targeted for conversion to mangrove, mud flat, and channel areas. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia)*. Methods for exotic vegetation removal, sediment excavation and use/removal, staging, containment, avoidance and minimization are the same as described in Section 3.1.1. The mangrove portions of the spoil areas will be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment, ±0.0' to 0.5' NGVD for mud flat, and the channel areas will be excavated to an elevation of ± (-)3.5' NGVD.

Two 72" diameter culverts, one at Spoil Area #2 and one at #3, are proposed to be installed at the west end of the proposed channels under the existing maintenance road to increase flushing to the mangroves west of the maintenance road. Prior to installation, silt fence and turbidity screens should be installed, as appropriate, to reduce turbidity. The culverts could be installed by excavating an appropriate portion of the existing maintenance road using a small excavator. Minor mangrove trimming may be necessary to install the culverts. Culverts could then be placed in the excavated area and covered with a portion of the excavated material to achieve the same elevation as prior to installation.

3.1.3 Spoil Areas #4 and #5

Spoil Areas #4 and #5 are targeted for conversion to seagrass creation areas. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia)*. Methods for exotic vegetation removal and excavation are the same as described for Spoil Area #1 above. The entire spoil areas are proposed to be excavated to an elevation of ± (-)2.0 for natural seagrass recruitment. Methods for exotic vegetation removal, sediment excavation and use/removal, staging, containment, avoidance and minimization are the same as described in Section 3.1.1.

Two 72" diameter culverts, one at Spoil Area #4 and one at #5, are proposed to be installed at the west end of the proposed channels under the existing maintenance road to increase flushing to the mangroves west of the maintenance road. Construction alternatives will be as described in Section 3.1.2.

3.1.4 Spoil Area #43

Spoil Area #43 is targeted for conversion to a mangrove creation area. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia)*. Methods for exotic vegetation removal and excavation are the same as described for Spoil Area #1 above. The entire spoil area is proposed to be excavated to an elevation of ± (-)2.0 for natural seagrass recruitment. Methods for exotic vegetation removal, sediment excavation and use/removal, staging, containment, avoidance and minimization are the same as described in Section 3.1.1.

3.1.5 Shoreline Protection along the ICWW

Shoreline protection is proposed as the primary means of erosion control along the heavily traveled ICWW. The preferred option is a riprap/crib structure that is designed to be placed within a ±5' wide footprint. Shoreline protection along the ICWW is proposed to protect it against erosion caused by storm events and wave energy generated by storms and boat traffic.

Prior to installation of the shoreline/crib, the landward edge of the seagrass beds are to be visibly demarcated to prevent impacts. The riprap/crib structure will consist of a crib with vertical and horizontal concrete filled PVC pipe piles. Riprap boulders of 1-3' size will be placed within this crib. The base of the crib is proposed to be a geotube or similar structure. This geotube may be filled with sand or material excavated from the spoil areas potentially using a Piranha Pump or similar suction dredging equipment. The base could then be used as a platform for the remainder of construction of the crib, eliminating the need for a heavy barge or crane. Vertical pilings for the crib could be jetted into the substrate using a hand-held machine or from a small johnboat. The vertical pilings are proposed to consist of a metal rebar core surrounded by a 4" diameter PVC pipe that would be filled with concrete. The PVC pipe would serve to contain the concrete and could allow the removal of the sediment within the tube by suction dredge. This proposed design minimizes the possibility of turbidity issues during pile installation. The horizontal rails of the crib is proposed to be constructed in a similar fashion and attached to the inside of the vertical pilings so that once riprap is placed within the crib the riprap boulders themselves would keep the horizontal railings in place.

The design of the riprap/crib structure will not block tidal flow into existing or proposed channels connecting West Lake to the ICWW. Placement is proposed to follow the horizontal contours of the shoreline and wrap around the sides of the channel inlets. It is anticipated that the riprap/crib structure will also stabilize the position of the channels by directing tidal currents.

From the existing riprap southward to the small mangrove island east of Spoil Area #1, the riprap/crib can be installed in open water and avoid mangrove and seagrass impacts. The installation of the riprap/crib can be performed from the geotube base and from small work boats with a maximum draft of 30". A barge could be staged at Port Everglades to store riprap and the small work boats could load from the barge for transport to the crib installation site.

For Areas #1-5, the riprap/crib can be constructed from land using the existing maintenance roads and could be installed at the upland edge except at Areas #4 and #5. At Areas #4 and #5, mangroves are present on the eastern edge of the spoil areas. The riprap/crib is proposed to be installed at the eastern edge of the mangroves in these two areas to protect them from erosion. This would require limited trimming of the mangroves for the riprap/crib placement.

For mangrove areas between Spoil Areas #1-5, the riprap/crib structure can be installed in the same manner as discussed above, working from the base and a shallow draft work boat. Some select mangrove trimming may be required in these areas.

3.1.6 Manatee Protection Areas

This improvement would most likely be performed from a boat/barge along the ICWW and will involve the installation of approximately 2,000 linear ft. of a barrier float system along Whiskey Creek. The buoy lines will be secured by anchoring them to the bottom at regular intervals and proposed be maintained by the BCPRD.

3.1.7 Remove Barges at Whiskey Creek

This improvement will most likely occur by attaching the barges, all of which are currently floating, to a vessel capable of moving them from their current location with minimal disturbance.

3.2 Phase 2 –Dania Beach Blvd. to Anne Kolb Nature Center

This phase includes the creation of mangrove, upland hammock, seagrass, mudflat, and channel areas from exotic plant-dominated Spoil Areas #6-13, and the installation of shoreline protection.

3.2.1 Spoil Areas #6 and #7

Spoil Area #6 is targeted for conversion to a mangrove creation area and Spoil Area #7 is targeted for a mudflat. These areas can be accessed from the ICWW using a shallow draft boat. Seagrasses are not present in the immediate vicinity of these areas and, therefore, should not be an issue.

Spoil Area #6 can be accessed from the ICWW by a small front-loading work boat that can bow up to the edge of the spoil area and offload equipment.

Mangroves completely surround Spoil Area #7 and therefore approximately 0.05 acres of mangrove impacts may be necessary to access this island. This narrow impact zone is proposed to be converted to a channel to allow proper flushing into and out of the proposed mudflat. The mangroves to be impacted are proposed to be removed by non-mechanical means.

To avoid and minimize impacts, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage prior to clearing. In addition, exotic vegetation should be removed by non-mechanical means where mangroves and other natural vegetation are in close proximity to the exotic vegetation. The pile could be burned in accordance with state and local regulations.

Spoil material could be used to 1) fill the geotubes or base discussed in Section 3.1.4, and/or 2) create the substrate for the ±2.0 acre mangrove creation area along the Dania Cutoff Canal that is discussed in Section 3.8. Excess spoil material should be removed from the site by suction dredge (such as a Piranha Pump) to a containment/settling area (such as the large Spoil Area #19 at the entrance to Anne Kolb Nature Center). This area could be cleared of exotic vegetation and serve as the settling area prior to its conversion to mangroves, mud flats, and channels as discussed in Section 3.3.1. The sediment/water slurry would be allowed to settle for an appropriate amount of time (per State criteria), and the return water could then be discharged via filtration and/or settlement into the ground and/or marsh. The point of discharge of the return water would be surrounded by a turbidity curtain and/or other appropriate turbidity control measures. The sediment would then be loaded onto dump trucks for transport to a suitable upland site and used for public purposes unless otherwise appropriately addressed.

Excavation of spoil material could proceed from the center of the spoil area outward to provide turbidity control and containment. Material could be excavated using appropriate mechanical means, such as a small backhoe and/or bulldozer that can access the spoil areas from a front loading work boat. Silt fencing/turbidity curtains shall be placed at the edge of mangroves after clearing of vegetation and would remain until the end of construction in this area. Spoil Area #6 is proposed to be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment and ± (-) 3.5' NGVD for a channel through the center of the area. Spoil Area #7 is proposed be excavated to an elevation of 0.0' to 0.5' NGVD for the mudflat and ± (-) 3.5' NGVD for a channel connecting the ICWW to the mudflat. The contractor shall be responsible for placement of spoil on a suitable upland site and used for public purposes unless otherwise appropriately addressed.

3.2.2 Spoil Areas #8-13

Spoil Areas #8, 9, 11, and 12 are targeted for conversion to seagrass creation areas. Spoil Area #10 is targeted for conversion to seagrass, mangrove, and upland hammock creation areas. Spoil Area #13 is targeted for conversion to mangrove, mudflat, upland hammock, and channel creation areas. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).*

Vegetation on the islands is proposed to be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation could access the spoil area by a shallow draft front loading work boat that could access the areas in-line with the channel between Areas #10 and #11. The area in front of and the channel itself is devoid of seagrasses; therefore, no seagrass impacts are anticipated. The boat could offload the equipment on Spoil Area #10. Temporary bridges could be erected between Spoil Area #10 and #9 and between Spoil Area #9 and #8 to allow access to those areas. To install the temporary bridges, approximately 0.02 and 0.07 acres of temporary mangrove impacts may occur, respectively. After construction, the temporary bridges would be removed to allow natural recruitment by mangroves.

Likewise, to access Spoil Area #11-13, a small front loading work boat could access Spoil Area #13 by approaching in-line with the channel between Areas #12 and #13. The boat could offload the equipment at Spoil Area #12. Temporary bridges could be erected between Spoil Area #12 and #11, and between Spoil Areas #12 and #13 to allow access to these areas. To install the temporary bridges, approximately 0.02 and 0.03 acres of mangrove impacts may occur, respectively. After construction, the temporary bridges would be removed to allow natural recruitment by mangroves.

To avoid and minimize impacts, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage prior to clearing. In addition, exotic vegetation could be removed by non-mechanical means where mangroves and other natural vegetation are in close proximity to the exotic vegetation. The pile could be burned in accordance with state and local regulations.

Excavation of spoil material is proposed to proceed from the center of the spoil area outward to provide turbidity control and containment. Material could be excavated using appropriate mechanical means, such as a small backhoe and/or bulldozer that can access the area by a front-loading workboat. Silt fencing/turbidity curtains would be placed at the edge of mangroves after clearing of vegetation and would remain until the end of construction in this area. The spoil areas are proposed to be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment, to ± (-) 1.5' NGVD to allow natural seagrass recruitment, to ± (-) 3.5' NGVD for the channels, and to 0.0' to 0.5' NGVD for the mudflat area. The upland hammock areas would not be excavated but graded prior to planting.

Spoil material could be used to 1) fill the geotubes or base discussed in Section 3.1.4, and/or 2) create the substrate for the ±2.0 acre mangrove creation area along the Dania Cutoff Canal that is discussed in Section 3.8 below. Excess spoil material could be removed from the site by suction dredge (such as a Piranha Pump) to a containment/settling area (such as the large Spoil Area #19 at the entrance to Anne Kolb

Nature Center). This area could be cleared of exotic vegetation and serve as the settling area prior to its conversion to mangroves, mud flats, and channels as discussed in Section 3.3.1 below. The sediment/water slurry would be allowed to settle for an appropriate amount of time (per State criteria), and the return water would then be discharged via filtration and/or settlement in the ground and/or marsh. The sediment would then be loaded onto dump trucks for transport to a suitable upland site and used for public purposes unless otherwise appropriately addressed.

If feasible, seagrasses from proposed impact sites will be transplanted to these seagrass creation areas.

3.2.5 Shoreline Protection along the ICWW

The riprap/crib structure is proposed to consist of a crib with vertical and horizontal concrete filled 4" to 6" PVC pipe piles. Riprap boulders of 1-3' size will be placed within this crib. Construction of the riprap crib is described in Section 3.1.4. The riprap/crib is proposed to be installed in upland spoil areas, open water, and along mangroves. This should require minimal trimming of mangrove prop roots and branches between the spoil areas, where necessary.

3.2.6 Manatee Protection Areas

This improvement would most likely be performed from a boat/barge along the ICWW and involve the installation of approximately 3,000 linear ft. of a barrier float system along the cove area between Dania Beach Blvd. and Sheridan Street. The buoy lines could be secured by anchoring them to the bottom at regular intervals and are proposed to be maintained by the BCPRD.

3.3 Phase 3 – Anne Kolb Nature Center to Bird Nesting Area

This phase includes the creation of mangrove, upland hammock, mudflat, and channel areas from exotic plant-dominated Spoil Areas #14-30 and #40-42, and installation of shoreline protection.

3.3.1 Spoil Areas #14-30 and #40-42

Spoil Areas #14-30, and #40-42 are targeted for conversion to mangrove, channel, mudflat, and upland hammock creation areas. The proposed improvements for these areas can be accessed from Anne Kolb Nature Center and existing maintenance roads; therefore, secondary impacts to adjacent resources are not anticipated.

Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia)*. Vegetation on the islands is proposed to be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation can access the spoil areas using the existing roads.

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To avoid and minimize impacts, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage prior to clearing. In addition, exotic vegetation could be removed by non-mechanical means where mangroves and other natural vegetation are in close proximity to the exotic vegetation. The pile could be burned or removed by truck using existing roads and disposed of in an appropriate upland location in accordance with state and local regulations.

Excavation of spoil material is proposed to proceed from the center of the spoil area outward to provide turbidity control and containment. Material could be excavated using appropriate mechanical means, such as a small backhoe and/or bulldozer that could access the area using the existing maintenance road. Silt fencing/turbidity curtains would be placed at the edge of mangroves after clearing of vegetation and would remain until the end of construction in this area. The spoil areas are proposed to be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment, ± (-) 3.5' NGVD for channels, and 0.0' to 0.5' NGVD for mudflats. The upland hammock areas should not be excavated but graded prior to planting.

Spoil material could be used to 1) fill the geotubes or base discussed in Section 3.1.4, and/or 2) create the substrate for the ±2.0 acre mangrove creation area along the Dania Cutoff Canal that is discussed in Section 3.8 below. Excess spoil material could be removed from the site by dump trucks using the existing roads. The contractor shall be responsible for placement of spoil on a suitable upland site and used for public purposes unless otherwise appropriately addressed. The contractor shall be responsible for placement of spoil on a suitable upland site and used for public purposes.

A small flushing channel is proposed west of Spoil Area #19 and #30 to connect existing channels to the interior lake. Approximately 0.68 acres of mangroves may be impacted and could be removed by non-mechanical means. The channels could be created by small using a small suction dredge such as a Piranha Pump to a containment/settling area (such as the large Spoil Area #19 at the entrance to Anne Kolb Nature Center and Spoil Area #30 south of Sheridan Street next to the bird nesting area). This area can be cleared of exotic vegetation and serve as the settling area prior to its conversion to mangroves, mud flats, and channels. The sediment/water slurry would be allowed to settle for an appropriate amount of time (per State criteria) and the return water would then be discharged via filtration and/or settlement in the ground and/or marsh. The sediment could then be loaded onto dump trucks for transport to a suitable upland site and used for public purposes unless otherwise appropriately addressed. The exact location of the channels will be field located to minimize mangrove impacts.

3.3.2 Enhance/Protect Bird Nesting and Feeding Habitat

This improvement can be accessed from existing maintenance roads and staged from Spoil Area #30 and the maintenance road. The existing channel could be dredged by using a small suction dredge such as a Piranha Pump to a containment/settling area (such as the large Spoil Area #30 adjacent to the bird nesting area). This area can be cleared of exotic vegetation and serve as the settling area prior to its conversion to mangroves, mud flats, and channels. The sediment/water slurry would be allowed to settle for an appropriate amount of time (per State criteria) and the return water would then be discharged via filtration and/or settlement in the ground and/or marsh. The sediment could then be loaded onto dump trucks for transport to a suitable upland site and used for public purposes unless otherwise appropriately addressed.

Felled trees that cross the channels are proposed to be removed and trees with branches that extend far over the channel would be trimmed. The contractor shall install and be responsible for maintenance of the appropriate turbidity controls (such as silt fence and floating turbidity barriers) for the duration of the project to ensure the continuous protection of water quality standards. Turbidity controls would be placed to protect existing mangrove areas and water bodies from silt and water-borne debris and prevent degradation of the water quality in surrounding waters.

3.3.3 Shoreline Protection along the ICWW

The riprap/crib structure is proposed to consist of a crib with vertical and horizontal concrete filled PVC pipe piles. Riprap boulders of 1-3' size are proposed to be placed within this crib. The base of the crib is proposed to be a geotube or similar structure that can be placed without the need of a barge or crane. The riprap crib can be constructed from land using the existing maintenance roads and Anne Kolb Nature Center. Where existing mangroves prohibit direct access to the shoreline for the riprap/crib placement, the riprap/crib could be constructed in the same manner as discussed in Section 3.1.4. The riprap/crib could be installed in upland spoil areas, open water, and along mangroves. This may require minimal trimming of mangrove prop roots and branches, if necessary.

3.3.4 Culverts along Maintenance Road

Two 72" diameter culverts will be installed under the existing maintenance road to increase flushing to the mangroves west of the maintenance road. Prior to installation, silt fence and turbidity screens are proposed to be installed to reduce turbidity. The culverts could be installed by excavating an appropriate portion of the existing maintenance road. Culverts could then be placed in the excavated area and covered with a portion of the excavated material to achieve the same elevation as prior to installation. Excess material may be removed from the site by truck to a suitable upland site and used for public purposes unless otherwise appropriately addressed.

3.4 Phase 4 – Bird Nesting Area to South End of Park

This phase includes the creation of upland hammock, and channel areas from exotic plant-dominated Spoil Areas #31-36 and installation of shoreline protection. Access to perform the improvements discussed below would be from the ICWW by a shallow-draft work vessel such as a pontoon boat.

3.4.1 Spoil Areas #31-36

Spoil Areas #31-36 are targeted for conversion to upland hammock. A small channel is also proposed through the eastern edge of Spoil Area #36.

Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).*

Vegetation on Spoil Areas #31-35 may be cleared, grubbed and piled using non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Access to these areas could be by a johnboat or similar equipment.

Vegetation on Spoil Area #36 is proposed to be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation can access the spoil area using the existing maintenance road.

To avoid and minimize impacts, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage prior to clearing. In addition, exotic vegetation may be removed by non-mechanical means where mangroves and other natural vegetation are in close proximity to the exotic vegetation. The pile could be burned or removed by truck using the existing maintenance road and disposed of in an appropriate upland location in accordance with state and local regulations.

3.4.2 Shoreline Protection along the ICWW

The riprap/crib structure is proposed to consist of a crib with vertical and horizontal concrete filled 4"-6" PVC pipe piles. Riprap boulders of 1-3' size are proposed to be placed within this crib. The base of the crib will be a geotube or similar structure. This geotube is proposed to be filled with sand or material excavated from the spoil areas. Construction of the riprap/crib can then proceed along the base, eliminating the need for a barge or crane. The design of the riprap/crib structure should not block tidal flow into existing or proposed channels connecting West Lake to the ICWW. Placement is proposed to follow the contours of the shoreline and wrap around the sides of the channel inlets. It is anticipated that the riprap/crib structure will also stabilize the position of the channels by directing tidal currents.

3.5 Phase 5 –West Lake Park Recreational Area/Sheridan Street

This phase includes the installation of new culverts to increase flushing, the creation of mangrove, mudflat, and channel areas from exotic plant-dominated Spoil Areas #37-39. West Lake Park Recreation Area provides access to and may serve as a suitable staging area. The proposed improvements for this phase can be accessed from the recreation area and, therefore, secondary impacts to adjacent resources are not anticipated.

3.5.1 Spoil Areas #37-39

Spoil Areas #37-39 are targeted for conversion to mangrove, channel, mudflat, and upland hammock creation areas. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia)*. Vegetation on the islands is proposed to be cleared, grubbed and piled. Prior to clearing, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage. Exotic vegetation is proposed to be cleared and grubbed using appropriate mechanical means except where mangroves and other natural vegetation is in close proximity to the exotic vegetation; in which case vegetation may be removed using non-mechanical means. The pile could be burned or removed by truck and/or disposed of in an appropriate upland location in accordance with state and local regulations.

Excavation of spoil material could be phased to provide turbidity control and containment (i.e. excavation will proceed from the center of the spoil area outward). Material will be excavated using appropriate mechanical means. Material could then be loaded onto trucks for transfer to the staging area. Silt fencing/turbidity curtains would be placed at the edge of mangroves after clearing of vegetation and would remain until the end of construction in this area. The spoil areas are proposed to be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment, ± (-) 3.5' NGVD for channels, and MSL for mudflats. The upland hammock areas would not be excavated but graded prior to planting. The contractor shall be responsible for placement of spoil on a suitable upland site and used for public purposes unless otherwise appropriately addressed.

3.5.2 Culvert under West Lake Park Entrance Road

One 72" diameter culvert shall be installed under the existing entrance road to increase flushing to the mangroves west of the road. Prior to installation, silt fence and turbidity screens should be installed to reduce turbidity.

3.6 Phase 6 – Dania Salt Marsh

This phase includes the excavation of new channels to increase flushing, the creation of mudflat creation areas from exotic plant-dominated areas, and desilting of certain channels and removal of blocks to water flow. The Florida Power & Light (FPL) substation along SE 5th Avenue could serve as a suitable staging area for this phase. The proposed improvements for this phase can be accessed from SE 5th Avenue. Minor secondary impacts to adjacent resources may occur but should be limited to trimming.

3.6.1 Flushing Channels from Existing Berms

The creation of new channels from existing berms would most likely be performed by using a small backhoe and excavator. They could access the site by laying a geogrid mat over the existing path that exists in the sea oxeye fields. This mat would be only wide enough for the small excavator and backhoe. The sediment could then be placed in a small Toolcat™ work machine for transport to the staging area. Another possibility is the use of a conveyor system that could transfer the excavated sediment directly to the staging area. These channels are proposed to be excavated to a ±(-) 3.5' NGVD unless bedrock is encountered above ±(-) 3.5' NGVD in which case the channel is proposed to be excavated to bedrock elevation. The contractor shall install, and be responsible for, maintenance of turbidity controls (silt fence and floating turbidity barriers) for the duration of the project to help ensure compliance with water quality standards. Turbidity controls should be placed, as appropriate, to protect existing mangrove areas and water bodies from silt and water-borne debris, preventing degradation of the water quality to surrounding waters and/or wetlands.

3.6.2 Mudflats from Exotic Plant-Dominated Areas

This improvement would most likely be performed using a small backhoe to excavate sediment to MSL. The existing historic haul road that is proposed to be converted to a channel could be used to access these mudflat creation areas. The channel would then be excavated from the mudflats to the historic haul road. The mudflats are proposed to be excavated to an elevation of 0.0' to 0.5' NGVD.

Existing exotic vegetation consists primarily of Brazilian pepper (*Schinus terebinthifolius*). Vegetation may be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation can access the spoil areas using the existing haul road and trail.

3.6.3 Flushing Channel along Historic Haul Road

The creation of a flushing channel along the historic haul road is proposed to be excavated in the manner described in Section 3.6.1. An existing trail could provide access to the site with minimal mangrove trimming. This channel is proposed to start on the north at the main double east-west channel and be approximately 30 feet wide. The channel is proposed to taper to about 15 feet wide on the southern end at its terminus at the southernmost created mudflat. Prior to excavation, the channel is proposed to be demarcated by visible means to protect mangroves outside the proposed channel from damage and to minimize mangrove impacts. The channel creation is proposed to follow the existing remains of a historic haul road. Up to 0.5 acres of white and black mangroves may, however, be impacted at the southern end of the channel to connect to the southern mudflat.

The channel is proposed to be excavated to a ±(-)3.5' NGVD unless bedrock is encountered above ±(-)3.5' NGVD in which case the channel is proposed to be excavated to bedrock elevation. The contractor shall install, and be responsible for, maintenance of turbidity controls (silt fence and floating turbidity barriers) for the duration of the project to help ensure compliance with water quality standards. Turbidity controls will be placed, as appropriate, to protect existing mangrove areas and water bodies from silt and water-borne debris; preventing degradation of the water quality to surrounding waters and/or wetlands.

3.6.4 Desilt Existing Channels

Desilting the primary channels would most likely be performed by using a small hydraulic dredge, such as a Piranha Pump to excavate sediment to the specified elevation. The sediment can be sent through hoses to the transport location. These channels are proposed to be desilted to a ±(-) 3.5' NGVD unless bedrock is encountered above ±(-) 3.5' NGVD in which case the channel will be desilted to bedrock elevation. The contractor shall install, and be responsible for, maintenance of turbidity controls (silt fence and floating turbidity barriers) for the duration of the project to help ensure compliance with water quality standards. Turbidity controls should be placed, as appropriate, to protect existing mangrove areas and water bodies from silt and water-borne debris, preventing degradation of the water quality to surrounding waters and/or wetlands. Turbidity controls will remain in place until side slope stabilization is achieved.

3.6.5 Protect/Preserve Sea Oxeye Fields from Exotic Invasion

The remaining sea oxeye fields in the DSM should be maintained free of exotic vegetation through quarterly monitoring. If exotic vegetation is observed, it shall be removed by hand or through chemical treatment, as appropriate.

3.7 Phase 7 – Exotic Vegetation Eradication

Approximately 8.4 acres of exotic plant-dominated areas throughout the Park are not targeted for habitat improvements. These areas are not targeted for other improvements because of their relative small size and/or accessibility. Exotic vegetation in these areas is proposed to be accessed on foot or by small vessel and exotic vegetation may be removed by non-mechanical means. Exotic vegetation shall be removed and planted with *Borrichia frutescens* and *B. arborescens*. Disposal shall be in a manner that will not encourage reinfestation by those nuisance/exotic species as well as comply with applicable State and local codes and regulations.

3.8 Phase 8 – Dania Cutoff Canal

Riprap should be placed north of existing riprap along the Dania Cutoff Canal (DCC). This riprap could most likely be placed from a shallow-draft barge with hand guidance. Some mangroves are present on the already existing, but poorly functioning, riprap. Therefore, any existing riprap with mangroves on them should remain in place. The relocation of the existing riprap is proposed to be permitted separately by others along with the installation of new bulkhead.

Following the proposed bulkhead and riprap installation along the DCC by others, approximately 2.0 acres are proposed to be filled behind the newly placed riprap to an elevation of ±0.9' to 1.4' to allow for mangrove recruitment. The average current elevation in this area is ±(-) 1.4' NGVD. Therefore, approximately 2.3' of fill will be required for the ±2.0 acre area. This results in a total of 7,421 cubic yards of fill.

Sediment from the spoil area excavation could be placed in this area from a barge along the Dania Cutoff Canal. The vertical sheet pile that may be installed for stability of the newly placed riprap could be extended to above the high tide line during construction to help ensure compliance with water quality standards. This may be comprised of temporary or supplemental sheet pile that will be adjusted to the appropriate final elevation. Floating turbidity curtains can be placed on the south side of this creation area to protect existing mangrove areas and water bodies from silt and waterborne debris; preventing degradation of the water quality to surrounding waters and/or wetlands.

3.9 *Archaeological and Historic Resources*

Based upon previous research by Florida Department of State Division of Historical Resources, it is not anticipated that historic or archaeological remains are present. However if historic or archaeological remains are discovered, the contractor shall be notify the appropriate Federal and State agencies. In addition, ground disturbing work in the immediate vicinity of artifacts if found will be halted until the area can be further investigated.

3.10 *Cleanup and Restoration*

During and upon completion of the project, the contractor shall keep the project site clean. The contractor should be allowed to temporarily store equipment, surplus materials, etc., within the limits of construction only if appropriately approved. No discarded equipment or materials, rubbish, or equipment material shall be placed outside of the construction limits.

Upon completion, the contractor shall remove from the project site and adjacent property all equipment, surplus and discarded materials, rubbish and temporary structures; the contractor shall restore, in an acceptable manner, property, both public and private, which may have been damaged during execution of the work. Waterways shall be left unobstructed upon project completion.

4.0 TURBIDITY MONITORING PLAN

Prior to and during construction operations that may generate turbidity within surface waters, erosion controls will be implemented as necessary to prevent exceeding turbidity standards as outlined in Chapter 62-302, F.A.C. Turbidity control devices used shall remain in place until turbidity, as measured in Nephelometric Turbidity Units (NTUs), within the work areas return to within 29 NTUs of background levels.

The contractor may be responsible for monitoring turbidity in areas where waterward construction activity occurs. Turbidity levels shall be monitored and recorded every six hours during dredging and filling. Samples shall be taken one foot below the surface and mid-depth at monitoring stations, which shall be located as follows:

- ±50' (up current) of the work sites and/or outside the influence of construction activities (control).
- Within ±50' down current of the work site and within the densest portion of any visible turbidity plume.

If turbidity exceeds standards (29 NTUs above background), work may be temporarily halted until the above standard is achieved.

The following data will be recorded and presented in each water quality monitoring report:

- permit and permit number
- dates of sampling and analysis
- turbidity sampling results
- description of data collection methods
- a map indicating the sampling locations
- time of sampling
- depth of water
- weather conditions at time sampling
- tidal stage and direction of flow
- wind direction and velocity
- water temperature

5.0 PLANTING SCHEDULE

UPLAND HAMMOCK CREATION - ±13.4 ACRES

Canopy/Shrub Layer

QUANTITY		SPECIES	SPACING	SIZE	ELEVATION (FT NGVD)
±343	±5%	*Conocarpus erectus* (Green buttonwood)	10' O.C.	3 gal.	±≥4.0
±343	±5%	*Conocarpus erectus* (Green buttonwood)	10' O.C.	7 gal.	±≥4.0
±343	±5%	*Bursera simaruba* (Gumbo limbo)	10' O.C.	3 gal.	±≥4.0
±343	±5%	*Bursera simaruba* (Gumbo limbo)	10' O.C.	10 gal.	±≥4.0
±343	±5%	*Coccoloba diversifolia* (Pigeon plum)	10' O.C.	7 gal.	±>4.0
±343	±5%	*Simarouba glauca* (Paradise tree)	10' O.C.	7 gal.	±≥4.0
±343	±5%	*Simarouba glauca* (Paradise tree)	10' O.C.	3 gal.	±≥4.0
±343	±5%	*Rapanea guianensis* (Myrsine)	10' O.C.	7 gal.	±≥4.0
±343	±5%	*Rapanea guianensis* (Myrsine)	10' O.C.	3 gal.	±≥4.0
±343	±5%	*Coccoloba uvifera* (Sea grape)	10' O.C.	7 gal.	±≥4.0
±343	±5%	*Coccoloba uvifera* (Sea grape)	10' O.C.	3 gal.	±≥4.0
±343	±5%	*Chrysophyllum oliviforme* (Satin leaf)	10' O.C.	7 gal.	±≥4.0
±343	±5%	*Chrysophyllum oliviforme* (Satin leaf)	10' O.C.	3 gal.	±≥4.0
±172	±5%	*Psychotria nervosa* (Wild coffee)	5' O.C.	3 gal.	±≥4.0
±172	±5%	*Hamelia patens* (Firebush)	5' O.C.	3 gal.	±≥4.0
±343	±5%	*Sabal palmetto* (Cabbage palm)	10' O.C.	8-14'	±≥4.0
±343	±5%	*Chrysobalanus icaco* (Cocoplum)	10' O.C.	7 gal.	±≥4.0
±343	±5%	*Chrysobalanus icaco* (Cocoplum)	10' O.C.	3 gal.	±≥4.0
±5,832	±5%	TOTAL			

Ground Cover

QUANTITY		SPECIES	SPACING	SIZE	ELEVATION (FT NGVD)
±21,000	±5%	*Spartina bakeri* (Cordgrass)	5' O.C.	bare root	±≥3.5
±4,500	±5%	*Nephrolepis biserrata* (Sword fern)	5' O.C.	1 gal.	±≥3.5
±25,500	±5%	TOTAL			

MANGROVE CREATION AREAS - ±24.2 ACRES

Canopy/Shrub layer vegetation will consist of naturally recruited mangrove species *(Rhizophora mangle, Avicennia germinans, and Laguncularia racemosa).*

EXOTIC VEGETATION REMOVAL AREAS - ±8.4ACRES

QUANTITY		SPECIES	SPACING	SIZE	ELEVATION (FT NGVD)
±20,328	±5%	*Borrichia frutescens* (sea oxeye daisy)	3' O.C.	1 gal.	±≥2.0
±20,328	±5%	*Borrichia arborescens* (sea oxeye daisy)	3' O.C.	1 gal.	±≥2.0
±40,656	±5%	TOTAL			

6.0 MONITORING PLAN

6.1 Seagrasses

A time-zero monitoring event will be performed, and then the seagrass recruitment area shall be monitored quarterly for the required five-year period.

Forty paired, one-square meter quadrats will be randomly placed within the created seagrass habitat during each monitoring event. Distribution of the forty quadrats will be divided equitably between the seven seagrass creation areas. Random, rather than fixed quadrats, will be used so that the results are without bias and can be used to accurately generalize over the entire area (Fonseca, personal communication). Random directions and distances will be chosen using a random number generator. The random direction and distance will be from the approximate center of each seagrass creation area. An equal number of replicate quadrats will be established in the adjacent, surrounding seagrass beds (at least 50' from the creation areas) to serve as a control. The following data will be collected at each quadrat:

- Relative water depth
- Time
- Species present
- Shoot counts
- Aerial coverage by photo-documentation
- Qualitative observations of natural seagrass recruitment and vegetative expansion of planting units

In addition to the above-listed data, the following data may also be collected for each monitoring event: tides, weather, water temperature, and wind. A staff gauge or piezometer shall be installed to record tide level.

Survivorship rates may be assessed based on measurements within the paired 1 m^2 quadrats. Abundance measurements shall be made through visual and photographic assessments of percent aerial coverage by species. The 1 m^2 quadrat shall be divided into 10 cm x 10 cm grid and the number of squares containing seagrasses shall be counted to estimate cover.

In addition, percent aerial coverage will be equated to Cover Classes, based on the Braun-Blanquet technique, as follows:

Cover Class	Description
0	Absent
0.1	Solitary individual ramet, less than 5% cover
0.5	Few individual ramets, less than 5% cover
1	Many individual ramets, less than 5% cover
2	5% - 25% cover
3	25% - 50% cover

Cover Class	Description
4	50% - 75% cover
5	75% - 100% cover

Seagrass success criteria shall be based on:

1. A target goal of Cover Class 1 coverage by the third year

2. A target goal of Cover Class 2 or higher by the fifth year

3. Supplemental seagrass will be planted on 2 m centers if:
   a) at the end of the third year areas have a Cover Class less than 1 or equivalent to coverage in the ICWW (control site) whichever is lower.
   b) at the end of the fifth year areas have a Cover Class less than 2 or equivalent to coverage in the ICWW (control site) whichever is lower.

The contingency plan for supplemental seagrass planting is to obtain donor stock from the adjacent seagrass beds and transplant the seagrasses using the plug method as described in Fonseca *et. al.* (1998) Guidelines *for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters.*

If the seagrass creation areas have not been completely covered by natural seagrass recruitment, seagrass from impact site(s) may be transplanted to the seagrass creation areas in West Lake Park.

Panoramic photo-stations shall be established and underwater photographic documentation of each quadrat shall also be collected.

Aquatic macrofauna (vertebrates and invertebrates) are proposed to be identified and recorded within the visible radius along 20 meter transects. This identification would be performed prior to monitoring of seagrasses to minimize disturbance. Benthic fauna would be identified, however interstitial fauna shall not. The following data shall be collected for each transect:

- Identification of fauna to lowest practical taxonomic level
- Number of individuals of a given species (abundance)
- Number of species (diversity)
- Location of identified fauna (sediment surface, water column)
- Behavior of identified fauna (swimming, foraging, etc.)
- Time to complete transect

In addition, incidental faunal observations shall be recorded.

6.2 Mangrove Areas

Vegetative sampling:

Establish one (1) belt transect within each individual mangrove recruitment area. These transects will be two (2) meters wide and will stretch across the approximate maximum length of each recruitment area. One square meter quadrats will be randomly placed along the transects at a minimum density of one (1) quadrat per 10 meters of transect (i.e., 100 meter transect will contain 10 quadrats). Though the quadrats will be randomly placed, they will not be placed within "breaks" (i.e., mud flats, pre-existing mangrove areas) in the mangrove recruitment areas. Percent aerial coverage by naturally recruited vegetative species falling within the quadrats will be visually estimated and recorded. Data from these sampling quadrats will then be extrapolated to determine overall percent coverage within each mangrove recruitment area.

Once naturally recruited mangrove trees have obtained sufficient height (±1.5 meters) to be recorded individually, trees falling within the belt transects (base of trunk within the transect) would be flagged and measured for height, spread, and diameter breast height (DBH). These measurements will be at random points along the transect at a frequency of one set of measurements per 10 meters. Measurements of these flagged trees will be repeated during subsequent monitoring events to determine growth rates. Overall health would also be assessed.

Success criteria:

Success criteria for mangroves and herbaceous plantings within mangrove recruitment areas will be based on percent coverage.

Percent coverage success criteria will be based on the following interim goals:

1. 10% aerial coverage by mangroves by the first year.
2. 40% aerial coverage by mangroves by the third year.
3. 80% aerial coverage by mangroves by the fifth year.

If the interim coverage mentioned above are not achieved, supplemental mangrove planting will be performed; red mangrove seedlings will be installed 3' on center in areas where coverage discrepancies are noted.

6.3 Mudflat/Tidal Pool Areas

Mud flat/tidal pool creation areas will be monitored for incidental wildlife, including benthic macroinvertebrates observed on the surface. Photo-documentation of each mudflat/tidal pool area and incidental wildlife observations will be recorded.

6.4 Upland hammock Areas

Vegetative sampling:

Establish one (1) belt transect within each individual upland hammock area. These transects will be two (2) meters wide and will stretch across the approximate maximum length of each planting area. One square meter will be randomly placed along the transects at a minimum density of one (1) quadrat per 10 meters of transect. Percent aerial coverage by installed and naturally recruited vegetative species falling within the quadrats will be visually estimated and recorded. Data from these sampling quadrats will then be extrapolated to determine overall percent coverage within each mangrove recruitment area.

All installed tree species falling within the belt transects (base of trunk within transect) will be flagged and measured for height, canopy spread, and DBH (if applicable). Measurements of these flagged trees will be repeated during subsequent monitoring events to determine growth rates. Overall health will also be assessed for each installed tree species.

Success criteria

Success criteria for tree/shrub species within the upland hammock areas shall be based upon survivorship rates of 80% or greater for planted species by the second annual monitoring period.

6.5 Success Criteria for Planting Areas

Success criteria is a target of 2% or less coverage by nuisance/exotic vegetative species within the recruitment/planting areas.

The following information will be included in the Time Zero and quarterly monitoring reports:

1) A summary of visual field observations, including survivorship and percent coverage or survivorship data obtained from the above-noted sampling activities.
2) Physical conditions during the monitoring event including: weather, wind direction and speed; tide direction, water temperature, salinity, and turbidity levels.
3) A photographic record taken from fixed photo stations.
4) Piezometer water level readings from the time period of monitoring activities.
5) Incidental observations of fish/wildlife utilization and sampling for aquatic macrofauna.
6) Evaluation of the success of the mitigation and maintenance effort.
7) Comments and/or recommendations for permit compliance.

7.0 MAINTENANCE PLAN

Maintenance shall be performed for a period of five (5) years and in perpetuity, as needed. A survival rate of 80% for installed tree/shrub species in the upland hammock planting areas, 80% coverage by desirable herbaceous species in the upland hammock areas, 80% for the planted species in the upland areas and 80% coverage of desirable obligate and facultative wetland species in the aquatic and marsh areas is anticipated through implementation of this mitigation program.

The permitee is responsible for the removal of nuisance and exotic vegetation and debris from the mitigation area for the length of the monitoring period and in perpetuity, as needed. Exotic vegetation shall include such species currently listed by the Florida Exotic Pest Plant Council. Mitigation areas shall be free from exotic/nuisance vegetation immediately following maintenance periods. Total coverage of exotic and nuisance species shall not exceed 2% between maintenance activities.

Maintenance is anticipated to be conducted during the monitoring period and in perpetuity, on an as needed basis. Appropriate methods of control shall be used, which will include, but will not necessarily be limited to, cutting, mowing, chemical treatment, hand removal, or any combination thereof.

Upon completion of the required 5-year monitoring period, BCPRD shall continue to be responsible for the perpetual maintenance and management of the mitigation areas.

8.0 SCHEDULE

Activities	Anticipated Date
Begin earthwork	6/05
Complete earthwork	6/08
Begin planting	7/08
Complete planting	7/09
Submit Time-zero Monitoring Report	8/09
Submit first Annual Monitoring Report	9/10
Submit Second Annual Monitoring Report	9/11
Submit Third Annual Monitoring Report	9/12
Submit Fourth Annual Mmonitoring Report	9/13
Submit Fifth Annual Monitoring Report	9/14

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		Size (Acres)	Project	Relative Functional Gain (RFG)	Mitigation Credit (FG)	Management Items
I. Master Plan – ESTIMATED MITIGATION CREDIT FOR WEST LAKE PROJECT						
A. Physical Habitat Alteration						
1	Structural habitat along the Intracoastal Waterway ICWW	1.9	Structure/ fill			
2	Mangrove protection and enhancement by riprap placement	24.0	Enhancement	0.26	6.24	
3	Supplemental structural habitat along Dania cut-off Canal	2.0	Structure/ fill			
4	Mangrove protection by riprap supplement	8.0	Enhancement	0.26	2.08	
5	Nuisance/Exotic Plant Control	8.4	Enhancement	0.11	0.92	
6	Spoil island and exotic dominated upland areas conversion					
6a	Mangrove	22.2	Creation	0.47	10.43	
6b	Mud Flat/tide pool	7.0	Creation	0.65	10.14	
6c	Channel	8.6				
6d	~~Seagrass~~	8.0	Creation	0.16	1.28	~~Seagrass~~
6e	Maritime Hammock	13.4	Creation	0.23	3.08	
7	Mangrove creation from Dania Cutoff Canal (open water)	2.0	Creation	0.21	0.42	
B. Land Acquisition (within existing park)						
1	Outparcel Acquisition	[redacted]				X
2	Vacate utility easements					X
3	Vacate FIND easements					X
4	Outparcel Acquisition (OUTSIDE IMPROVEMENT AREAS)	23.3	Preserv.	0.06	1.40	
C. Habitat Improvements						
1	Creation of Mantee Protection Areas					
1a	Seagrass/manatee ~~protection area in Whiskey Creek~~ (WC)	9.0	Preserv.	0.03	1.0	~~Seagrass~~
1b	Seagrass/manatee ~~protection – ICWW south of Dania~~ Beach Blvd.	21.0				~~Seagrass~~
2	Enhance/protect bird nesting, and feeding habitat	[redacted]				X
3	Establishment of Osprey towers					X
4	Mud flat/tide pool creation from Brazilian pepper areas in Dania Salt Marsh	1.5	Restoration	0.22	0.33	
5	Protect/preserve sea oxeye fields from exotic invasion	10.0	Enhancement	0.22	2.20	
D. Hydrologic Improvements						
1	Dania Salt Marsh (DSM)/flushing channel improvements	3.5	Enhancement	0.22	0.77	
2	Desilt existing culverts	[redacted]				X
3	Increase number of or upsize culverts					X
4	Desilting channels/ongoing maintenance dredging					X
E. Miscellaneous Improvements						
1	Remove the barges at ~~Whiskey Creek~~ (expose ~~bottom for SAV recruitment~~)	0.5	Enhancement	0.08	0.04	~~Seagrass~~
	TOTAL	**174.30**				
	Mangrove Mitigation Credits				20.57	
	~~**Seagrass Mitigation**~~				**2.22**	
	Other Mitigation Credits				**17.45**	

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

ATTACHMENT 6

West Lake Mitigation - Methods to Determine Acreages for Improvements

		Method to Determine Acreage
I. Conceptual Master Plan		
A. Physical Habitat Alteration		
1	Rip rap placement along the Intracoastal Waterway ICWW	As-built survey
1a	Mangrove protection and enhancement by riprap placement	Areas Subject to Erosion Exhibit - previously submitted
2	Supplemental placement/enhancement of rip rap along Dania cut-off Canal	As-built survey
2a	Mangrove protection by riprap supplement	Areas Subject to Erosion Exhibit - previously submitted
3	Nuisance/Exotic Plant Control	As-built survey
4	Spoil island and exotic dominated upland areas conversion	
4a	Mangrove	As-built survey
4b	Mud Flat/tide pool	As-built survey
4c	Channel	As-built survey
4d	Seagrass	As-built survey
4e	Maritime Hammock	As-built survey
4f	Edge effect enhancement of areas surrounding 4a - 4e	
5	Mangrove creation from Dania Cutoff Canal (open water)	As-built survey
B. Land Acquisition (within existing park)		
1	Within ICWW south of Dania Beach Blvd.	Proof of ownership, Conservation easement, sketch & description
2	Vacate utility easements	Proof of ownership, Conservation easement, sketch & description
3	Vacate FIND easements	Proof of ownership, Conservation easement, sketch & description
4	Outparcel Acquisition	Proof of ownership, Conservation easement, sketch & description
5	Sheridan Street ESL addition (former Albertsons site)	Proof of ownership, Conservation easement, sketch & description
C. Habitat Improvements		
1	Creation of Mantee Protection Areas	
1a	Manatee protection area in Whiskey Creek (WC)	Acreage calculation within MPA buoyed-area
1b	Seagrass protection by manatee protection area in WC	Acreage calculation within MPA buoyed-area
1c	Manatee protection - ICWW south of Dania Beach Blvd.	Acreage calculation within MPA buoyed-area
1d	Seagrass protection by manatee protection area in ICWW	Acreage calculation within MPA buoyed-area
2	Crocodile basking within Dania Salt Marsh	As-built survey
3	Enhance/protect bird nesting, and feeding habitat	As-built survey
4	Establishment of Osprey towers	As-built survey
5	Stabilize areas with herbaceous planting	As-built survey
6	Mud flat/tide pool creation from exotic-dominated sea oxeye fields	As-built survey
D. Hydrologic Improvements		
1	Dania Salt Marsh (DSM)/flushing channel improvements	As-built survey
1a	Improvements from flushing channels in DSM and throughout Park	As-built survey from #1
2	Desilt existing culverts	As-built survey
2a	Enhancement of mangroves from desilting culverts	As-built survey from #2
3	Increase number of or upsize culverts	As-built survey
3a	Enhancement of mangroves from increasing culverts	As-built survey from #3
4	Desilting channels/ongoing maintenance dredging	As-built survey
4a	Improvements to mangroves/lakes by desilting	As-built survey from #4
E. Miscellaneous Improvements		
1	Remove the barges at Whiskey Creek (expose bottom for SAV recruitment)	Photos showing barges gone
2	Increase educational signage througout park	Photos of signs installed at park
F. Additional Factors		
1	Conservation easement over County-owned land	Sketch and Description

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US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)
ATTACHMENT 7

West Lake Mitigation Unit Estimates

#	Item	Creation (Acres)	Restoration (Acres)	Enhancement (Acres)	Preservation (Acres)	Management Items
		Mitigation Items				
I. Master Plan						
A. Physical Habitat Alteration						
1	Structural habitat along the Intracoastal Waterway ICWW	1.9				
2	Mangrove protection and enhancement by riprap placement			24.0		
3	Supplemental structural habitat along Dania cut-off Canal	2.0				
4	Mangrove protection by riprap supplement			8.0		
5	Nuisance/Exotic Plant Control			8.4		
6	Spoil island and exotic dominated upland areas conversion					
6a	Mangrove	22.2				
6b	Mud Flat/tide pool	7.0				
6c	Channel	8.6				
6d	Seagrass	8.0				
6e	Maritime Hammock	13.4				
7	Mangrove creation from Dania Cutoff Canal (open water)	2.0				
B. Land Acquisition (within existing park)						
1	Outparcel Acquisition					X
2	Vacate utility easements					X
3	Vacate FIND easements					X
4	Outparcel Acquisition (OUTSIDE IMPROVEMENT AREAS)				23.3	
C. Habitat Improvements						
1	Creation of Mantee Protection Areas					
1a	Seagrass/manatee protection area in Whiskey Creek (WC)				9.0	
1b	Seagrass/manatee protection - ICWW south of Dania Beach Blvd.				21.0	
2	Enhance/protect bird nesting, and feeding habitat					X
3	Establishment of Osprey towers					X
4	Mud flat/tide pool creation from Brazilian pepper areas in Dania Salt Marsh		1.5			
5	Protect/preserve sea oxeye fields from exotic invasion			10.0		
D. Hydrologic Improvements						
1	Dania Salt Marsh (DSM)/flushing channel improvements		3.5			
2	Desilt existing culverts					X
3	Increase number of or upsize culverts					X
4	Desilting channels/ongoing maintenance dredging					X
E. Miscellaneous Improvements						
1	Remove the barges at Whiskey Creek (expose bottom for SAV recruitment)		0.5			
	TOTAL	65.1	5.5	50.4	53.3	

***Definitions**

Creation = The establishment of new wetlands or surface waters by conversion of other land forms.

Restoration = Converting back to a historic condition those wetlands, surface waters, or uplands which currently exist as a land form which differs from the historic condition.

Enhancement = Improving the ecological value of wetlands, other surface waters, or uplands that have been degraded in comparison to their historic condition

Preservation = The protection of wetlands, other surface waters or uplands from adverse impacts by placing a conservation easement or other comparable land use restriction over the property or by donation of fee simple interest in the property.

Management Items - Items that the Broward County Parks and Recreation Department plan to do, however mitigation credit is not being requested for these items at this time. These items may be considered and evaluated by the reviewing agencies for credit, if applicable, at that time.

US Army Corps of Engineers

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File # SAJ-2002-72(IP-LAO)
ATTACHMENT 8

CESAJ-RD-S
SAJ-2002-00072(IP-LAO)

FEB 2 8 2006

MEMORANDUM FOR RECORD

SUBJECT: Department of the Army Environmental Assessment and Statement of Finding for Above-Numbered Permit Application

1. Applicant: Broward County Parks and Recreation Division
   Attn: Pat Young
   Administrative Manager
   950 N.W. 38th Street
   Oakland Park, FL 33309

2. Location, Existing Site Conditions, Project Description Changes to Project:

a. Location: The project is located in West Lake Park, a county park composed almost entirely of a mangrove forest west of the Intracoastal Waterway and south of the Dania Cutoff Canal, Dania Beach (Sections 1, 2 and 11, Township 50 south, Range 42 east, Broward County, Florida.

b. Existing Site Conditions: The project site contains ±1,522 acres of which ±990.5 acres are mangrove swamps, ±246.9 acres are lakes, ±65.3 acres are exotic plant dominated spoil areas, and ±221.7 acres are other habitats, including waterways, saltwater marsh, tidal flats, barren land, seagrass, roads, and highways. The site is a public park facility managed by the Broward County Parks and Recreation Division. The mangrove swamps, lakes, waterways, saltwater marshes, and tidal flats are considered to be jurisdictional waters of the United States. The site is bordered by the Dania Cut-off Canal to the north, the ICWW to the east, and residential to the south and west. Because of the site's proximity to the ICW and high speed boat traffic, erosion is an concern for Park Managers.

The project site is comprised primarily of mangrove dominated estuarine wetlands, with the red (*Rhizophora mangle*), black (*Avicennia germans*), and white (*Languncularia racemosa*) mangrove species present. Green buttonwood (*Conocarpus erectus*) and silver buttonwood (*Conocarpus erectus* var. *sericeus*) are also present, typically growing on higher elevations than the mangroves. Isolated sea ox-eye daisy (*Borrichia* spp.) marshes are also found within western portions of the project site. In addition, two large manmade interconnected lakes are present within this park.

Paddle grass and Johnson's seagrass are present within the Intracoastal Waterway adjacent to West Lake Park. The dominant seagrass is paddle grass (*Halophila decipiens*). Johnson's seagrass (*Halophila johnsonii*), a Threatened species, is present throughout, but is more prevalent on the southern end. Shoal grass (*Halodule wrightii*) is also present. These seagrasses are present as patchy beds of varying density, usually with rubble and overgrowing algae interspersed.

Paddle grass and Johnson's seagrass were also present within the interior lakes in areas where the sediment was somewhat compacted and where limestone was present with overlying sediment of 3 inches or less. The largest concentration of seagrass within the interior lakes of West Lake Park is at the extreme southern end.

The nuisance/exotic species Australian pine (*Casuarina equisetifolia*) is established on the spoil islands and other fill areas associated with historic dredging of West Lake and the Intracoastal Waterway. Brazilian pepper (*Schinus terebinthifolius*) is also established in many locations in the Dania Salt Marsh area of the Park.

c. Project Description: To provide up-front compensation to be used for wetland impacts associated with future Broward County projects, the County has proposed a mitigation plan for upland, wetland, and seagrass creation, restoration, enhancement and preservation of mangroves and seagrasses within West Lake Park in Broward County.

The project in is to install culvert connections to increase flushing of a 1500+ acre mangrove forest, construct a riprap/crib structure for shoreline stabilization along approximately 3 miles of shoreline adjacent to the mangrove edge along the ICW and for approximately 1.5 miles along the Dania Cutoff canal. The riprap/crib structure shall be created using piling supports on one or both sides of the riprap with pilings parallel to the shoreline with horizontal reinforcing bars to create the support structure for the riprap. A geotube base filled with clean fill will be laid within the crib strucuture for stabilization. Where the structure is adjacent to resources, as shown in the attached drawings, riprap placement will be within a 5-foot wide crib structure which is vertical on both sides with pilings and stringers. Where the riprap will not be placed adjacent to resources, the piling support structure will be only built on the landward edge of the mangrove fringe and the riprap will be placed against and waterward of it with the waterward slope of the riprap being no steeper than 1.5 horizontal to 1 vertical.

The project will also include the scrape down and/or removal of exotic vegetation from approximately 63 acres of upland soil to create mangrove, mudflat, tidal flats and pools, seagrass, and maritime hammock habitat. Additionally, exotic vegetation removal will occur in smaller areas throughout the park. A temporary expansion of an existing road involving 0.03 acres of impacts will be installed to allow spoil removal.

The project is proposed to create ±24.2 acres of mangrove habitat, 7.0 acres of mud flats/tidal pools, 8.6 acres of tidal channels, 8.0 acres of seagrass habitat, 13.4 acres of maritime hammock, 1.9 acres of structural habitat in the form of a riprap crib structure along the ICWW, and 2.0 acres of supplemental structural habitat (riprap) along the Dania Cut-off Canal. Project restoration would consist of 1.5 acres of mud flats/tide pools, and improving 3.5 acres of flushing channels within the Dania Salt Marsh, and removing derelict barges which currently shade 0.5 acres of potential seagrass habitat within Whiskey Creek. Project enhancement/creation consists of 32 acres of mangroves, removal of 8.4 acres of exotic vegetation and replanting of sea oxeye daisy, and removing and preventing future exotic infestations in 10 acres. Project preservation consists of 23.3 acres of outparcel acquisition, and 30 acres of seagrass/manatee protection areas.

Ecological benefits generated from the proposed improvement may be used as mitigation to offset future estuarine wetland impacts associated, if appropriate, with projects conducted by or for Broward County. The Corps will determine if mitigation credit for this project is warranted and appropriate for use as mitigation on other projects. Any habitat restoration or enhancement that occurs as a result of this project does not preclude the need to fully adhere to the federal sequential mitigation requirements on future regulated activities.

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SUBJECT: Department of the Army Environmental Assessment and Statement of Findings for the Above-Numbered Permit Application

While post-project monitoring will reveal if actual habitat creation and enhancement occurs, these ecological benefits were estimated using the Uniform Mitigation Assessment Method (UMAM) and are summarized in the following table:

		Size (Acres)	**Project**	**Relative Functional Gain (RFG)**	**Mitigation Credit (FG)**	**Management Items**
I. Master Plan						
A. Physical Habitat Alteration						
1	Structural habitat along the Intracoastal Waterway ICWW	1.9	Structure/ fill		-1.24	
2	Mangrove protection and enhancement by riprap placement	24.0	Enhancement	.26	6.24	
3	Supplemental structural habitat along Dania cut-off Canal	2.0	Structure/ fill			
4	Mangrove protection by riprap supplement	8.0	Enhancement	.26	2.08	
5	Nuisance/Exotic Plant Control	8.4	Enhancement	.11	0.92	
6	Spoil island and exotic dominated upland areas conversion					
6a	Mangrove	22.2	Creation	.47	10.43	
6b	Mud Flat/tide pool	7.0	Creation	.65	10.14	
6c	Channel	8.6				
6d	Seagrass	8.0	Creation	.16	1.28	
6e	Maritime Hammock	13.4	Creation	.23	3.08	
7	Mangrove creation from Dania Cutoff Canal (open water)	2.0	Creation	0.21	0.42	
B. Land Acquisition (within existing park)						
1	Outparcel Acquisition	[redacted]	[redacted]	[redacted]	[redacted]	X
2	Vacate utility easements	[redacted]	[redacted]	[redacted]	[redacted]	X
3	Vacate FIND easements	[redacted]	[redacted]	[redacted]	[redacted]	X
4	Outparcel Acquisition (OUTSIDE IMPROVEMENT AREAS)	23.3	Preservation	0.06	1.40	
C. Habitat Improvements						
1	Creation of Mantee Protection Areas					
1a	Seagrass/manatee protection area in Whiskey Creek (WC)	9.0	Preservation	0.03	0.9	
1b	Seagrass/manatee protection - ICWW south of Dania Beach Blvd.	21.0				
2	Enhance/protect bird nesting, and feeding habitat	[redacted]	[redacted]	[redacted]	[redacted]	X

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		Size (Acres)	**Project**	**Relative Functional Gain (RFG)**	**Mitigation Credit (FG)**		**Management Items**
3	Establishment of Osprey towers	[redacted]					X
4	Mud flat/tide pool creation from Brazilian pepper areas in Dania Salt Marsh	1.5	Restoration	0.22	0.33		
5	Protect/preserve sea oxeye fields from exotic invasion	10.0	Enhancement	0.22	2.20		
D.	**Hydrologic Improvements**						
1	Dania Salt Marsh (DSM)/flushing channel improvements	3.5	Enhancement	0.22	0.77		
2	Desilt existing culverts	[redacted]					X
3	Increase number of or upsize culverts						X
4	Desilting channels/ongoing maintenance dredging						X
E.	**Miscellaneous Improvements**						
1	Remove the barges at Whiskey Creek (expose bottom for SAV recruitment)	0.5	Enhancement	0.08	0.04		
	TOTAL	**174.30**					
	Mangrove Mitigation Credits				**20.57**		
	Seagrass Mitigation Credits				**2.28**		
	Other Mitigation Credits				**17.45**		

While the Corps recognizes the value of the mudflats, tidal pools and channels to a healthy mangrove system, future use of mitigation credits earned through the creation of these habitats in order to offset mangrove or other habitat impacts should be done only when deemed appropriate by the Corps.

d. Changes to Project: The following changes have been made to the proposed improvements from the original to the current submittal that has resulted in avoidance and minimization of wetland impacts for the project:

a. The proposed channels and mudflats behind Spoil Island #13 have been eliminated to avoid mangrove impacts.

b. Riprap (the original shoreline protection option) was deemed to have too great an impact to resources (mangroves and seagrass) due to the 15'-20' footprint.

Multiple alternative alignments were investigated. The project was then changed to a crib only structure that is only 5' wide with the riprap held between the two sided piling support structure. However, the creation of the crib structure alone was believed to create secondary impacts by the creation of vertical structure and the severing of flow of water and fauna into and out of the mangrove forest. In order to balance the need for stabilization of the mangroves with the need to avoid other impacts to resources, the project was broken up into separate areas. Whenever possible the riprap will be constructed with a piling supported back structure with a riprap height of +5 NGVD. The riprap will be placed in front of it at a slope no steeper than 1.5:1 horizontal:vertical. In areas adjacent to seagrasses, the crib structure shall be utilized with a 5-foot wide crib filled with riprap. Placement of the crib structure will be micro-sited to ensure avoidance of all seagrass impacts. To ensure flow through the riprap structure, gaps between the riprap structure will be created as shown in the attached drawings.

c. All but one of the proposed channels just north of Sheridan Street near Anne Kolb Nature Center have been eliminated to reduce mangrove impacts to a minimum.

d. Proposed channel desilting in the Dania Salt Marsh has been reduced from desilting four channels to desilting only 25% of the main central channel at the western edge to reduce significant mangrove trimming and removal that would be necessary to accomplish the originally proposed desilting effort.

e. The large flushing channel proposed in the Dania Salt Marsh has been reduced in width from 50' to a variable width ranging from 30' to 15' to reduce mangrove impacts.

f. The locations of certain mangrove recruitment areas and upland hammock have been relocated to reduce the amount of material that would need to be removed from more isolated locations (i.e. areas that would have to be accessed by boat).

A combined total of ±15 acres of direct mangrove impacts have been eliminated since the original design.

3. Project Purpose:

a. Basic: The project's basic purpose is the enhancement and restoration of a tidal and estuarine system.

b. Overall: The overall project purpose is to provide ecological benefits and improvement to a tidal and estuarine system located at West Lake Park within eastern Broward County, Florida.

4. Scope of Analysis: The corps' jurisdiction includes the proposed project site and the surrounding areas where construction equipment will be staged/located. The proposed project site does exhibit unique and/or rare characteristics. However, it is these characteristics that are proposed for restoration and enhancement.

5. Statutory Authority: Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344).

6. Other Federal, State, and Local Authorizations Obtained or Required and Pending:

a. State Permit/Certification: The South Florida Water Management District (SFWMD) permit number 06-04016-P was issued on 22 April 2004.

b. Coastal Zone Management (CZM) consistency/permit: Issuance of a SFWMD permit certifies that the project is consistent with the CZM plan.

c. Other Authorizations: Broward County Department of Planning and Environmental Protection (DPEP) issued Environmental Resource License number DF30-1117 on 12 AUG 2004.

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SUBJECT: Department of the Army Environmental Assessment and Statement of Findings for the Above-Numbered Permit Application

7. Date of Public Notice and Summary of Comments:

a. Pre-application meeting(s): The Corps attended a pre-application meeting on site on 6 SEP 2000. In attendance were Pat Young, Gil MacAdam, Mike Kroll, Dylan Larson, and Bob Paulson.

b. Important Dates: The Corps, Jacksonville District received the application on 11 January 2002. The Corps project manager requested additional information necessary to complete a Public Notice for an Individual Permit on 24 April 2002. The applicant responded with additional information on 10 June 2002, and the Corps considered the application complete. The Corps conducted a jurisdictional determination on 16 August 2002. The Corps completed the Public Notice on 21 November 2003, which was published on the web. The Public Notice was sent to all interested parties including appropriate State and Federal agencies.

c. Public Notice Comments: The Corps has reviewed all of the comments submitted in response to the circulation of the Public Notice. The Corps has summarized these comments below:

(1) U.S. Environmental Protection Agency (EPA): The EPA responded to the Public Notice on 19 DEC 2003. The EPA requested Estuarine-Wetland Rapid Assessment Procedure (E-WRAP) scores for the proposed project, as well as a table which lists the total amount of credits and debits that would be generated by the proposed project. In addition, the EPA requested detailed drawings with an explanation of how the proposed riprap construction will affect fisheries and wildlife habitat.

(2) U.S. Fish and Wildlife Service (USFWS): The USFWS responded to the Public Notice on 26 JAN 2004. The USFWS concurred with the Corps determination that the project may affect, but is not likely to adversely affect the West Indian Manatee or result in adverse modification to critical manatee habitat. The USFWS also concurred with the Corps determination that the project may affect but not likely to affect the wood stork. On 22 April 2005, the Corps sent an additional request for coordination to the US FWS for the American Crocodile. By letter dated 18 July 2005, the US FWS concurred with the Corps determination that the project may affect, but is not likely to

adversely affect the American crocodile. The USFWS therefore did not object to the proposed project.

(3) National Marine Fisheries Service (NMFS)-Habitat Conservation Division: The NMFS-HCD responded to the Public Notice on 9 DEC 2003. The NMFS stated concerns that construction of the proposed riprap crib would damage existing habitats and would occupy submerged bottoms that are used for movement between requisite forage, cover and maturation sites, ultimately reducing the abundance and diversity of fishery resources in the area. In addition, water movement could be restricted and localized water quality degradation could result. NMFS has recommended that alternatives to creation of the riprap crib be explored. Further evaluation of enforcement issues involving vessel wake and shoreline erosion at West Lake Park was also recommended as part of the alternatives analysis.

(4) National Marine Fisheries Service (NMFS)-Protected Resources Division: The NMFS-PRD responded by letter dated 9 DEC 2003. The NMFS-PRD concurred with the Corps determination that the project may affect, but is not likely to adversely affect Johnson's seagrass or result in adverse modification to Johnson's seagrass critical habitat. The NMFS-PRD also concurred with the Corps determination that the project may affect but not likely to affect the small toothed sawfish or swimming seaturtles. The NMFS-PRD therefore did not object to the proposed project.

(5) State Historic Preservation Officer (SHPO): By letter dated 5 December 2003, the SHPO indicated that no significant archaeological or historical resources are recorded within the project area.

(5) Other State and local agencies: No other agencies responded to the public notice.

(6) Organizations: No organizations responded to the public notice.

(7) Individuals: By letter dated 12 December 2003, Mr. Steven Tarr, President of Stelly-Hoven, Inc., owner of a lot within the State park area objected to the issuance of a

Department of the Army permit for this work stating that the project would directly and indirectly affect his lot. Mr. Tarr's lot is at the most waterward part of the mangrove forest. There are no access roads to it and it is on the coastline that is eroding at an estimated rate of 1.5 ft/year. There is a condition of the SFWMD permit that the project cannot be performed on an project location that is not owned or under easement by the applicant, Broward County. Additionally, the county is taking steps to obtain ownership of several outparcels which may be affected by various stages of this project. Therefore, the Corps believes that Mr. Tarr's property rights are being adequately considered.

(8) Internal Coordination: The project was coordinated with the Construction/Operations Division due to its proximity to the ICW. Construction Operations did not object to the project.

8. Alternatives:

a. No less damaging alternatives were available which would have provided the same ecological benefits and utilization of the site. Selection of another site is not feasible, as the site consists of tidal and estuarine habitats, which are the targeted habitats for the desired restoration. Through project modifications, approximately 15 cres of impact to mangrove wetlands were avoided.

b. Minimization: The project has been minimized to the maximum extent possible as discussed on page 5 under Section D (Changes to the project). The project proposes temporary, minimal incidental impacts. The Corps believes the end result of the restoration and enhancement activities would be more beneficial to the aquatic environment than the current condition which will result in continued loss of mangrove habitat. A review of alternative stabilization methods was reviewed and the proposed method is the least environmentally damaging alternative that would meet the project purpose. No less damaging alternatives were available which would have provided the same environmental benefits and utilization of the site.

c. Mitigation: Mitigation is not proposed for the temporary, minimal, incidental impacts to the existing resources since implementation of the proposed ecological improvements will benefit the entire estuarine system at West Lake Park.

d. Conclusions of Alternatives Analysis: The Corps believes that the overall ecological improvements to the site will offset the temporary minimal incidental impacts. The project as proposed represents the less damaging, practicable alternative.

9. Evaluation of the 404(b)(1) Guidelines: The Corps reviewed the proposed project in accordance with the 404 (b)(1) Guidelines. The review demonstrates that the Corps analyzed all of the alternatives and that the proposed alternative is the least environmentally damaging and practicable alternative considering expense, existing technology, and logistics. The project would not cause or contribute to violations of State Water quality standards, jeopardize the existence of any endangered species or affect a marine sanctuary. The Corps does not expect significant degradation and the Applicant has taken all available practicable steps to minimize impacts.

a. Restrictions on discharges:

(1) Alternatives (See paragraph 8):

(a) The activity is located in a special aquatic site (wetlands, sanctuaries and refuges, mud flats, vegetated shallows, coral reefs, riffle and pool complexes).

(b) The activity does need to be located in a special aquatic site to fulfill its basic purpose.

(c) It has been demonstrated in paragraph 8 above that there are no practicable nor less damaging alternatives which would satisfy the project's overall purpose.

(2) Other program requirements

(a) The proposed activity does not violate applicable State water quality standards or Section 307 prohibitions or effluent standards.

(b) The proposed activity does not jeopardize the continued existence of federally listed threatened or endangered species or affect their critical habitat.

(c) The proposed activity does not violate the requirements of a federally designated marine sanctuary.

(3) The activity will not cause or contribute to significant degradation of waters of the United States, including adverse effects on human health, life stages of aquatic organisms, ecosystem diversity, productivity and stability; and recreational, aesthetic, and economic values.

(4) Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.

b. Findings: The proposed site for the discharge of dredged or fill material complies with the Section 404 (b)(1) Guidelines with the inclusion of the following special conditions:

Special Conditions:

1. Submittals required herein shall be directed to:

Department of the Army
Jacksonville District Corps of Engineers
Regulatory Division, Enforcement Section
P.O. Box 4970
Jacksonville, Florida 32232-0019

A courtesy copy of any required enhancement/creation reports will also be provided to:

U.S. Army Corps of Engineers
South Permits Branch Office
4400 PGA Boulevard, Suite 500

Palm Beach Gardens, FL 33410

2. Prior to commencement of construction in or adjacent to wetlands and/or Waters of the United States, the perimeter of the enhancement/creation construction area(s) shall be enclosed with staked and trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas.

3. Appropriated soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date.

4. The permittee shall conduct a pre-construction meeting prior to commencement of construction in order to notify in-house staff, field crews, contractors, subcontractors, and all persons involved in the construction of West Lake Park Enhancement/creation Project of the conditions of this permit. The permittee shall educate and inform staff members and contractors of these procedures. Copies of the permit and specific conditions shall be displayed at the construction site.

5. All storage or stockpiling of tools or materials (i.e. lumber, pilings, etc.) shall be limited to uplands or within the impact areas authorized by this project.

6. All temporary wetland impacts associated with the enhancement/creation construction activities shall be restored to preexisting wetland conditions immediately following completion of the construction element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time-zero enhancement/creation monitoring report and shall be maintained and monitored in conjunction with the enhancement/creation monitoring program provided for in the enclosed exhibits.

7. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the Corps may require the permittee to provide appropriate enhancement/creation to the Corps. The Corps may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

8. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or Waters of the United States prior to disposal in a suitable upland spoil disposal area.

9. The permittee shall comply with the attached Manatee Construction Conditions enclosed in attachment #3 which are also outlined in this condition. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

The permittee shall advise all construction personnel that there are civil penalties and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water wherever possible.

If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee(s). these precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida. Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 8 ½ by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida.

10. The permittee shall install and maintain permanent manatee awareness signs/education displays.

11. As provided in Attachment 4, Broward County Parks and Recreation Division shall be responsible for the enhancement/creation construction, five year maintenance and

monitoring and perpetual management of the proposed enhancement/creation efforts at West Lake Park.

12. A maintenance program shall be implemented in accordance with Attachment 5 for the enhancement/creation areas on a regular basis to ensure the integrity and viability of those areas as permitted. Maintenance shall be conducted in perpetuity to ensure that the enhancement/creation areas are maintained free from Category 1 exotic vegetation (as defined by the Florida Exotic Pest Plant Council at the time of permit issuance) immediately following a maintenance activity. Coverage of exotic and nuisance plant species shall not exceed 5% of total cover between maintenance activities. In addition, the permittee shall manage the conservation areas such that exotic/nuisance plant species do not dominate any one section of those areas.

13. A time zero monitoring report for the West Lake Park enhancement/creation project shall be conducted in accordance with Attachment 5 for all completed enhancement/creation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

14. The permittee shall submit annual monitoring reports to the Corps for a period of five years, the first not later than one year after the submission of the time-zero report. Each monitoring report shall provide a narrative, professional biological opinion of the condition of the enhancement/creation improvements. The monitoring report shall also contain a plan view describing the vegetative community, the percent cover for each community, a list of species and their percent cover for each community, the percent cover of wetland and of exotic plant species, the sum of the survivors of those planted plus those recruited, a description of any unusual climatic or other factors, and

photos from the same point as where the photos for the time-zero report.

15. Perpetual maintenance of the enhancement/creation areas shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

16. Generally, the enhancement/creation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater, and/or estuarine wetland communities. The use of mitigation units from this project shall be limited to projects undertaken by or for Broward County. The Corps will determine if the use of mitigation credits from this project is warranted and appropriate for use as mitigation on other projects. The suitability of this enhancement/creation area to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

17. The amount of potential credit generated by the enhancement/creation efforts must be confirmed through post-project monitoring to reveal if actual habitat creation and enhancement/creation occurs. These ecological benefits were estimated using the Uniform Enhancement/creation Assessment Method (UMAM) and are summarized in Attachment 6. The values are presumed correct, but are adjustable by the Corps if adequate lift has not been achieved or if proposed acreages for mitigation areas are not enhanced/created as proposed. Verification methods to determine actual acreages for Improvement and verification of potential credits generated from this creation/enhancement project are shown in Attachment 7. Use of such enhancement/creation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the enhancement/creation credit. Any habitat restoration/enhancement/creation that occurs as a result of

this project does not preclude the need to fully adhere to the federal sequential enhancement/creation requirements on future regulated activities.

*Corps UMAM scores on this project were done separately from those submitted by the applicant in conjunction with SFWMD, future scoring should be done in line with those values which can be found in the file.

18. Management items identified in Attachment 8 and described in Attachment 4 may be later considered for enhancement/creation credit through a modification of this permit if supporting information to justify enhancement/creation credit for items has been sufficiently demonstrated to the Corps.

19. No modifications to this permit shall be required for construction methodology variations from those described in Attachment 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that Corps staff concurs with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by Corps regulatory or compliance staff.

20. Select mangrove trimming necessary to accomplish the planned enhancement/creation efforts described herein shall be authorized by this permit.

*This condition is to allow installation of the crib structure among the mangroves on the most southern 1/3 end of the project area. In order to avoid impacting seagrasses in these areas, the crib structure shall be placed within the edge of the mangroves. Therefore, it will be necessary to perform some selective trimming and possibly minor root removal without affecting the health of any mangroves.

21. Since the installation of the buoys for the 'boating exclusion zone" is located within the Federal right-of-way for the Federal Channel, **a Department of the Army Consent to Easement is also required *prior* to commencement of construction.** By copy of this letter, the permit is being

forwarded to the Corps Real Estate Division for action on the Consent.

22. Enhancement/creation credit for the designated manatee/seagrass protection areas shall be granted only after documentation of a Consent to Easement for installation of the manatee protection barriers from the U.S. Army Corps of Engineers Real Estate Division has been submitted to the offices outlined in Special Condition #1.

*This credit for preservation is based on the belief that by creating a boating exclusion zone along the shoreline and in Whiskey Creek, the overall impacts to the seagrass from boat wakes and other impacts will provide a net benefit. If the barrier is not installed and maintained permanently, then no credit should be given.

23. The Permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structures or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the Permittee will be required, upon due notice from the U.S. Army Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

24. Fill material used with this project (temporary road expansion and geotube creation) shall be limited to suitable, clean fill material, which excludes materials such as trash, debris, car bodies, asphalt, construction materials, concrete block with exposed reinforcement bars, and any soils contaminated with any toxic substance in toxic amounts (see Section 307 of the Clean Water Act).

25. Following completion of the crib installation, the permittee shall complete a post-installation seagrass survey from the riprap crib structure waterward for a distance 50

feet. This post construction seagrass survey will be conducted in the growing season (April 1-August 31) following the crib construction and shall be submitted to Corps no later than October 1 that year. The seagrass survey shall be compared with the 2002 seagrass survey done by Miller Legg and Associates, Inc. If the post construction seagrass survey shows that seagrasses have been impacted or are no longer growing in their previous locations (adjacent to the crib structure), a UMAM analysis on the seagrass habitats affected based on the Corps earlier UMAM analysis of the West Lake Seagrass areas should be conducted by the permittee and submitted to the Corps for approval. The UMAM debits from the areas affected shall be deducted from any actual seagrass creation/enhancement credits earned through this overall project. If sufficient actual mitigation credits are not available to offset the impacts caused to seagrasses by the crib structure, the Corps will require remedial measures and will require additional mitigation as necessary to fully offset impacts resulting from the installation of the crib structure.

*The applicant was encouraged to avoid installation of the crib structure along the seagrass areas and to instead install a sloped riprap structure. The Corps is concerned that the crib structure may act similar to a vertical seawall with energy rebound which may affect the ability for seagrass to grow in a these areas. However, due to the close proximity of mangroves and seagrass, the wider footprint of the sloped riprap would have created an immediate impact for one habitat type or the other. The permittee stated that because of the permeability and roughness (not a solid sheet) of the riprap structure that even though it is vertical there should not be the same energy rebound off of it. The seagrass survey will be required to ensure that the grasses adjacent to the crib structure is not required. Because the sloped riprap is not being placed adjacent to seagrass areas, there is no need to provide a post project survey for these areas.

10. Public Interest Review:

a. Public interest factors: The Corps reviewed all of the public interest factors including, but not limited to, the effects the work might have on conservation, economics, esthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, land use, navigation, shore erosion and accretion, recreation, water quality, safety, and consideration of property ownership. The Corps has determined that the proposed project will not adversely affect any of the public interest factors.

b. Describe the relative extent of the public and private need for the proposed structure or work: The public need includes increase fish and wildlife utilization and conservation, habitat protection, and an increase in natural areas for recreational and educational use.

c. Describe the practicability of using reasonable alternative locations and methods to accomplish the objective of the proposed work where there are unresolved conflicts as to resource use: There are no unresolved conflicts regarding resource use. The proposed project is consistent with the land use classification.

d. Describe the extent and permanence of the beneficial and/or detrimental effects, which the proposed work is likely to have on the public, and private uses to which the area is suited: Detrimental impacts are expected to be temporary during construction. Beneficial effects associated with the project and the public benefits listed above would be permanent.

e. Threatened or endangered species: After coordination on endangered species, the USFWS concurred with the Corps' determination that the proposed project may affect, but is not likely to adversely affect the West Indian manatee, the wood stork, and the American Crocodile and would not adversely affect Manatee Critical Habitat. The NMFS-PRD concurred with the Corps' determination that the project may affect, but would not likely adversely affect Johnson's seagrass or its critical habitat, the small toothed sawfish, or swimming seaturtles.

f. Corps wetland policy: The proposed temporary minimal incidental impacts are necessary to achieve the project purpose.

The proposed work should not result in any adverse environmental impacts. The benefits of the project associated with overall ecological improvements offset the temporary minimal incidental impacts. Therefore, the project is in accordance with the Corps wetland policy.

g. Cumulative and Secondary Impacts: Cumulative and/or secondary impacts are not anticipated as a result of the project. The proposed project will not have an adverse cumulative effect on the aquatic ecosystem because the impacts are minimal, temporary, incidental, and are not for development purposes. The site is surrounded by the ICWW to the east the Dania Cut-off Canal to the north and residential development to the west and south.

h. Corps analysis of comments and responses: The Corps is in agreement with the comments from the United States FWS and the NMFS and the subsequent responses of the applicant.

11. Essential Fish Habitat (EFH): The project will incidentally affect but not adversely affect essential fish habitat because the proposed project involves habitat creation, restoration, enhancement, and preservation including hydrologic improvements to West Lake Park that will provide improvements to Essential Fish Habitat. Coordination with NMFS - HCD with respect to EFH was resolved on February 6, 2006 with a final letter that states the following:

> …NMFS notes that post-project monitoring will reveal if actual habitat creation and enhancement occurs. Further, additional coordination with NMFS would be necessary to determine if credit is warranted and appropriate for use as mitigation on other projects *(see note below)*. Also, we emphasize that any habitat restoration or enhancement that occurs as a result of this project does not preclude the need to fully adhere to the federal sequential mitigation requirements on future regulated activities.
>
> We appreciate efforts by the applicant and your staff to protect NMFS' trust resources. With inclusion of the aforementioned changes as special conditions of the issued DA permit, the goals of the Magnuson-Stevens Fishery

Conservation and Management Act and the regulations for implementing the EFH requirements of the Act would be met.

Note - The Corps did not agree to coordinate with NMFS on future projects to determine if credit usage from this enhancement is warranted and appropriate for use as mitigation on other projects. Other projects will undergo their own EFH review and appropriateness of mitigation can be addressed through that process.

12. Public Hearing Evaluation: No public hearing was requested; therefore, no public hearing was held.

13. Determinations:

a. Finding of No Significant Impact (FONSI): Having reviewed the information provided by the applicant and all interested parties and an assessment of the environmental impacts, I find that this permit action will not have a significant impact on the quality of the human environment. Therefore, an Environmental Impact Statement will not be required.

b. Compliance with 404(b)(1) Guidelines: Having completed the evaluation in paragraph 9 above, I have determined that the proposed discharge complies with the 404 (b)(1) guidelines.

c. Section 176 (c) of the Clean Air Act General Conformity Rule Review: The proposed permit action has been analyzed for conformity applicability pursuant to regulations implementing Section 176 (c) of the Clean Air Act. It has been determined that the activities proposed under this permit will not exceed de minimus levels of direct or indirect emissions of a criteria pollutant or its precursors and are exempted by 40 CFR Part 93.153. Any later indirect emissions are generally not within the Corps' continuing program responsibility and generally cannot be practicably controlled by the Corps. For these reasons a conformity determination is not required for this permit action.

d. Public Interest Determination: I find that the issuance of a department of the Army permit is not contrary to the public interest.

CESAJ-RD-S **SAJ-2002-00072(IP-LAO)**
SUBJECT: Department of the Army Environmental Assessment and Statement of Findings for the Above-Numbered Permit Application

PREPARED BY:

Leah A. Oberlin
Project Manager

REVIEWED BY:

John F. Studt
Chief, South Permits Branch

APPROVED BY:

Robert M. Carpenter
Colonel, Corps of Engineers
Commanding

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
4400 PGA BOULEVARD, SUITE 500
PALM BEACH GARDENS, FLORIDA 33410

REPLY TO
ATTENTION OF

FEB 03 2011

Palm Beach Gardens Section
SAJ-2002-00072(IP-LAO)
Modification-5

Broward County Parks and Recreation Division
c/o Pat Young
Administrative Manager
950 NW 38th Street
Oakland Park, Florida 33309

Dear Mr. Young:

The U.S. Army Corps of Engineers has completed the review and evaluation of your modification request received 24 January 2011 in which you asked to modify Department of the Army permit number SAJ-2002-00072, for activities at the West Lake Park and adjacent wetlands, issued February 28, 2006. The project is located in navigable waters of the U.S, west of the Intracoastal Waterway and south of the Dania Cutoff Canal, Dania Beach (Sections 1, 2, and 11, Township 50 south, Range 42 east), Broward County, Florida.

The proposed modification is to extend the expiration date to complete your proposed project. This authorization is hereby extended for five years from the date of this letter.

The impact of your proposal on navigation and the environment has been reviewed and found to be insignificant. The permit is hereby modified in accordance with your request. You should attach this letter to the permit. All other conditions of the permit remain in full force and effect.

If you have any questions concerning permit modification, please contact the project manager Melody White at the letterhead address, by telephone at 561-472-3508 or by electronic mail at Melody.J.White@usace.army.mil.

Thank you for your cooperation with our permit program. The Corps Jacksonville District Regulatory Division is committed to improving service to our customers. We strive to perform our duty in a friendly and timely manner while working to preserve our environment. We invite you to take a few minutes to visit http://per2.nwp.usace.army.mil/survey.html and complete our automated Customer Service Survey. Your input is appreciated - favorable or otherwise.

Please be aware this web address is case sensitive and should be entered as it appears above.

BY AUTHORITY OF THE SECRETARY OF THE ARMY:

Alfred A. Pantano, Jr.
Colonel, U.S. Army
District Commander

Enclosure

Copies Furnished:

Miller Legg
c/o Dylan Larson
2005 Vista Parkway
Suite 100
West Palm Beach, FL 33411
Email: Jennifer Shipley: jshipley@millerlegg.com
Dylan Larson: dlarson@millerlegg.com

CESAJ-RD-PE

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

3301 Gun Club Road, West Palm Beach, Florida 33406 • (561) 686-8800 • FL WATS 1-800-432-2045 • TDD (561) 697-2574
Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680 • www.sfwmd.gov

CON 24

Permit No. 06-04016-P
Application No. 011226-21

April 22, 2004

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
(WEST LAKE PARK)
115 SOUTH ANDREWS AVE STE 421
FT LAUDERDALE, FL 33301

Dear Permittee:

Enclosed is your Permit as authorized by the Governing Board of the South Florida Water Management District at its meeting on April 14, 2004.

Please note that there are pre-construction documentation requirements which must be met prior to commencement of any construction. Failure to comply with these requirements may result in formal enforcement action to force cessation of construction activities pending permit compliance.

Special Conditions to your Permit require reports to be filed with this District. Please read these Conditions and use the enclosed form(s), as applicable, for your submittal of these required reports.

Should you have any questions concerning these requirements, please feel free to contact this office.

Sincerely,

Elizabeth Veguilla
Deputy Clerk
Environmental Resource Regulation Department

Enclosures

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENVIRONMENTAL RESOURCE PERMIT NO. 06-04016-P
DATE ISSUED: APRIL 14, 2004

FORM #0145
Rev. 08/95

PERMITTEE: STATE OF FLORIDA
(WEST LAKE PARK)
DIVISION OF STATE LANDS,3900 COMMONWEALTH BOULEVARD
TALLAHASSEE, FL 32399

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
(WEST LAKE PARK)
115 SOUTH ANDREWS AVE,STE 421
FT LAUDERDALE, FL 33301

PROJECT DESCRIPTION: AUTHORIZATION FOR CONSTRUCTION AND OPERATION OF A MITIGATION PROJECT WITHIN THE 1522.2 ACRE WEST LAKE PARK TO PROVIDE COMPENSATION FOR FUTURE WETLAND IMPACTS THAT MAY BE ASSOCIATED WITH FUTURE BROWARD COUNTY PROJECTS

PROJECT LOCATION: BROWARD COUNTY, SECTION 35,36 TWP 50S RGE 42E
SECTION 1,2,11 TWP 51S RGE 42E

PERMIT DURATION: See Special Condition No:1. See attached Rule 40E-4.321, Florida Administrative Code.

This Permit is issued pursuant to Application No. 011226-21 , date(December 13, 2001. Permittee agrees to hold and save the South Florida Water Management District and its successors harmless from any and all damages, claims or liabilities which may arise by reason of the construction, operation, maintenance or use of activities authorized by this Permit. This Permit is issued under the provisions of Chapter 373 , Part IV Florida Statutes (F.S.), and the Operating Agreement Concerning Regulation Under Part IV, Chapter 373 F.S., between South Florida Water Management District and the Department of Environmental Protection. Issuance of this Permit constitutes certification of compliance with state water quality standards where neccessary pursuant to Section 401, Public Law 92-500, 33 USC Section 1341 , unless this Permit is issued pursuant to the net improvement provisions of Subsections 373.414(1)(b), F.S., or as otherwise stated herein.

This Permit may be transferred pursuant to the appropriate provisions of Chapter 373, F.S, and Sections 40E-1.6107(1) and (2), and 40E-4.351(1), (2), and (4), Florida Administrative Code (F.A.C.). This Permit may be revoked, suspended, or modified at any time pursuant to the appropriate provisions of Chapter 373, F.S. and Sections 40E-4.351(1), (2), and (4), F.A.C.

This Permit shall be subject to the General Conditions set forth in Rule 40E-4.381, F.A.C., unless waived or modified by the Governing Board. The Application, and the Environmental Resource Permit Staff Review Summary of the Application, including all conditions, and all plans and specifications incorporated by reference, are a part of this Permit. All activities authorized by this Permit shall be implemented as set forth in the plans, specifications, and performance criteria as set forth and incorporated in the Environmental Resource Permit Staff Review Summary. Within 30 days after completion of construction of the permitted activity, the Permittee shall submit a written statement of completion and certification by a registered professional engineer or other appropriate individual, pursuant to the appropriate provisions of Chapter 373, F.S. and Sections 40E-4.361 and 40E-4.381, F.A.C.

In the event the property is sold or otherwise conveyed, the Permittee will remain liable for compliance with this Permit until transfer is approved by the District pursuant to Rule 40E-1.6107, F.A.C.

SPECIAL AND GENERAL CONDITIONS ARE AS FOLLOWS:

SEE PAGES 2 - 7 OF 10 (41 SPECIAL CONDITIONS).
SEE PAGES 8 - 10 OF 10 (19 GENERAL CONDITIONS).

FILED WITH THE CLERK OF THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT

ON April 22, 2004

BY [signature]
DEPUTY CLERK

SOUTH FLORIDA WATER MANAGEMENT DISTRICT, BY ITS GOVERNING BOARD

BY [signature]
ASSISTANT SECRETARY

SOUTH FLORIDA WATER MANAGEMENT DISTRICT BOARD OF GOVERNORS — STATE OF FLORIDA — SEAL — Established 1949

SPECIAL CONDITIONS

1. The construction phase of this permit shall expire on April 15, 2009.

2. The permittee shall be responsible for the correction of any erosion, shoaling or water quality problems that result from the construction or operation of the surface water management system.

3. Measures shall be taken during construction to insure that sedimentation and/or turbidity violations do not occur in the receiving water.

4. The District reserves the right to require that additional water quality treatment methods be incorporated into the drainage system if such measures are shown to be necessary.

5. Facilities other than those stated herein shall not be constructed without an approved modification of this permit.

6. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the District may require the permittee to provide appropriate mitigation to the District or other impacted party. The District may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

7. All barge activity shall occur in areas where a minimum one-foot bottom clearance is maintained.

8. All contractors must be provided with a copy of the staff report and permit conditions prior to the commencement of construction. The permittee is responsible for ensuring that all contractors adhere to the project construction details and methods indicated on the attached permit Exhibits and described herein.

9. The successful completion of the mitigation plan is heavily dependent on proper site grading. Therefore, prior to demobilizing equipment from the site and prior to planting, the permittee shall schedule an inspection by District Environmental Resource Compliance staff to ensure that appropriate elevations and slopes have been achieved.

10. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or other surface waters prior to disposal in a suitable upland spoil disposal area.

11. Prior to the commencement of construction in or adjacent to wetlands and/or other surface waters, the perimeter of the mitigation construction area(s) shall be enclosed with stakedand trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas. The permittee shall notify the District's Environmental Resource Compliance staff in writing upon installation of the silt fencing and/or turbidity screens and schedule an inspection of this work. The silt fencing and/or turbidity screens shall be subject to District staff approval. The permittee shall modify the silt fencing/turbidity screens if District staff determines that it is insufficient or is not in conformance with the intent of this permit. The silt fencing and/or turbidity screens shall remain in place until all adjacent construction activities are complete.

12. All temporary wetland impacts associated with mitigation construction activities shall be restored to preexisting wetland conditions immediately following completion of the mitigation element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time zero mitigation monitoring report and shall be maintained and monitored in conjunction with the mitigation monitoring program provided for in the enclosed exhibits.

13. This permit only applies to authorization from the South Florida Water Management District; it is possible that additional permits may be necessary from other agencies. Nothing contained herein relieves the permittee from timely complying with applicable laws of other federal, state or local governments.

14. Manatee exclusion grates shall be placed across the openings of existing or proposed culverts or pipes that are greater than eighteen inches but smaller than six feet in diameter. The installation of grates applies to any submerged or partially submerged pipes and culverts accessible to manatees during any tidal phase. Permittee shall keep all grates free and clear of debris.

15. Endangered species, threatened species and/or species of special concern have been observed onsite and/or the project contains suitable habitat for these species. It shall be the permittee's responsibility to coordinate with the Florida Fish and Wildlife Conservation Commission and/or the U.S. Fish and Wildlife Service for appropriate guidance, recommendations and/or necessary permits to avoid impacts to listed species.

16. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (1-561-562-3909) in south Florida.

Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 81/2" by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. The U.S. Fish and Wildlife Service should also be contacted in Jacksonville (1-904-232-2580) for north Florida or in

Vero Beach (1-561-562-3909) for south Florida.

17. Due to the proximity of this project to areas of known manatee concentrations, all work conducted waterward of the existing shoreline during the months of December, January and February shall be subject to the following conditions:

a) The Bureau of Protected Species Management shall be notified one week prior to the commencement of the work;

b) at least one person shall be designated as a manatee observer at each site when in-water work is being performed. the manatee observer must be on site during all in-water construction activities and will advise personnel to cease operation upon sighting a manatee within 50 feet of any in-water construction activity. Movement of a work barge, other associated vessels, or any in-water work shall not be performed after sunset, when the possibility of spotting manatees is negligible; and

c) the permittee shall ensure that the contractor maintains a log detailing sightings, collisions, or injuries to manatees should they occur during the contract period. Following project completion, the logs shall be submitted to the Bureau of Protected Species Management, 620 South Meridian Street, Tallahassee, Florida 32399-1600;

18. The following exhibits for the permit are incorporated by reference herein and are located in the permit file:

Exhibit No. 14 List of Outparcels within West Lake Natural Preserve and Recreation Area, dated 12/19/01
Exhibit No. 17 Sublease Agreement for West Lake Park, between FDNR and Broward County, executed 12/22/88
Exhibit No. 18 Management Plan for West Lake Park, by Broward County Parks and Recreation Division
Exhibit No. 19 Management Plan Update for West Lake Park, authorized by FDEP on 2/7/02

19. No construction is authorized on land that the permittee does not own until the permittee acquires title to such land.

20. This permit does not eliminate the need to obtain any and all necessary easements and rights of way prior to the start of any activity approved herein. This permit does not convey to the permittee, or create for the permittee, any property right, or any interest in real property; nor does it authorize any entrance upon, or activities on, property which is not owned or controlled by the permittee; or convey any rights or privileges other than those specified in the permit and Chapter 40E-4 or Chapter 40E-40, F.A.C..

21. As provided in Exhibit No. 10, Broward County Parks and Recreation Division shall be responsible for the mitigation construction, five year maintenance and monitoring and perpetual management of the proposed mitigation efforts at West Lake Park.

22. Perpetual maintenance of the mitigation area shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

23. The use of the mitigation units from this project shall be limited to projects undertaken by Broward County. Generally, the mitigation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater and/or estuarine wetland communities. The suitability of this mitigation area to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

The amount of potential credit generated by the mitigation efforts has been determined using the Uniform Mitigation Assessment Method, 62-345, FAC (UMAM) through an assessment conducted jointly by District and Broward County Department of Planning and Environmental Protection staff and the applicant's representatives and is reflected in the UMAM worksheets provided in Exhibit No. 22. Use of the mitigation credits shall be addressed at the time of application for the wetland impact projects.

24. At the time of application for any that includes wetland impacts and proposes to use mitigation credit from this West Lake mitigation plan, the permittee shall demonstrate that an adequate portion of the mitigation plan has been or shall be executed and completed in a timely manner (i.e., concurrent with the wetland impacts) and that the specified mitigation will adequately offset the wetland impacts associated with that construction project.

25. A mitigation program for West Lake Park shall be implemented in accordance with the enclosed exhibits. The permittee shall create 51.7 acres of wetlands, restore 5.5 acres of wetlands, restore 13.4 acres of uplands, enhance 50.4 acres of wetlands, and preserve 53.3 acres of wetlands.

26. The District reserves the right to require remedial measures to be taken by the permittee if monitoring or other information demonstrates that adverse impacts to onsite or offsite wetlands, upland conservation areas or buffers, or other surface waters have occurred due to project related activities.

27. A mitigation monitoring program shall be implemented in accordance with the enclosed exhibits to ensure that the targeted success criteria are met. The monitoring program shall extend for a period of 5 years with annual reports submitted to District Environmental Resource Compliance staff. The permittee shall be responsible for ensuring that the mitigation areas described herein meet the specified percent coverage and/or survivorship of planted and/or recruited vegetation throughout the duration of the monitoring program, with replanting as necessary. If native wetland, transitional, and upland species do not achieve the specified percent coverage and/or survivorship at any time during the monitoring program, native species shall be planted in accordance with the maintenance program. At the end of the 5 year monitoring program the entire mitigation area shall contain an 80% survival of planted vegetation and an 80% coverage of desirable plant species suitable for that mitigation area.

28. A maintenance program shall be implemented in accordance with Exhibit Nos. 4 and 7 for the mitigation areas on a regular basis to ensure the integrity and viability of those areas as permitted. Maintenance shall be conducted in perpetuity to ensure that the conservation area is maintained free from Category 1 exotic vegetation (as defined by the Florida Exotic Pest Plant Council at the time of permit issuance) immediately following a maintenance activity. Coverage of exotic and nuisance plant species shall not exceed 5% of total cover between maintenance activities. In addition, the permittee shall manage the conservation areas such that exotic/nuisance plant species do not dominate any one section of those areas.

29. A time zero monitoring report for the West Lake Park mitigation project shall be conducted in accordance with Exhibit Nos. 4 and 7 for all completed mitigation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

30. The permittee shall comply with applicable state water quality standards including:
a) 62-302.500 - Minimum criteria for all surface waters at all places and all times;
b) 62-302.510 - Surface waters: general criteria
c) 62-302.560 - Class III waters; recreation, propagation and maintenance of a healthy, well balanced population of fish and wildlife;
d) 62-302.600 - Classified waters.

31. A turbidity control plan shall be implemented in accordance with Exhibit Nos. 4 and 7. Prior to the commencement of construction in or adjacent to the Intracoastal Waterway or other surface water bodies within West Lake Park, floating turbidity curtains with weighted skirts that extend to the submerged bottom shall be properly installed to isolate adjacent waters from the work area. The floating turbidity curtains shall be maintained and shall remain in place until all construction is complete and turbidity levels in the project area are within 29 NTUs of background levels. The permittee shall be responsible for ensuring that turbidity control devices are inspected daily and maintained in good working order so that there are no violations of state water quality standards outside of the turbidity screens.

32. A water quality monitoring program shall be implemented in accordance with Exhibit No. 4 and as outlined below:

Turbidity expressed in nephelometric turbidity units (ntu). Background samples shall be taken 200 feet upstream of any construction activity within adjacent surface waters Samples shall also be taken 200 feet downstream. Samples shall be taken at least twice daily, with at least a four-hour interval, during all work authorized by this permit involving spoil removal, grading or other forms of earthwork that may generate turbidity in other surface waters.

Monitoring shall begin on the first day of construction for all activities within or adjacent to surface waters. Monitoring shall cease when all construction activities are completed. The monitoring data must demonstrate that turbidity 200 feet downstream of all proposed activities is less than or equal to 29 NTU's above natural background turbidity (or meets OFW standards) and 200 feet upstream of each proposed activity for a period of 7 consecutive days after completion of construction. If monitoring shows such levels to be exceeded, construction shall cease and District compliance staff shall be notified immediately. Work shall not resume until District staff is satisfied that adequate corrective measures have been taken and turbidity has returned to acceptable levels.

All monitoring data shall be maintained on site and be available to District staff during regular business hours. The content of the data shall include:

1) permit and application number; (2) dates of sampling and analysis; (3) statement describing the methods used in collection, handling, storage and analysis of the samples; (4) a map indicating the sampling locations and (5) a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, limits of detection and accuracy of the data.

Monitoring reports shall also include the following information for each sample that is taken:

(a) time of day samples taken;
(b) depth of water body;
(c) depth of samples;
(d) antecedent weather conditions;
(e) wind direction and velocity;

33. Documentation of ownership of the Priority 1 outparcels by the County identified in Exhibit Nos. 14 and 15 must be provided to the District in order to be credited as mitigation for preservation credit and before any other mitigation element is constructed which relies on those outparcels for their construction, access or other purposes.

34. Those portions of the park which are under County ownership and where mitigation is proposed that have been determined to potentially be vulnerable to subsequent alteration (refer to Exhibit No. 13) shall be placed under a conservation easement dedicated to the District. A draft conservation easement document along with boundary surveys and legal descriptions for the identified areas to be protected under the conservation easement shall be submitted for review by District staff and, upon their approval, shall be recorded in County records before mitigation credit for those areas may be used as compensation to offset wetland impacts associated

with other County projects.

35. Management items outlined in Exhibit No. 5 and described in Exhibit Nos. 4 and 7 may be later considered for mitigation credit through a modification of this permit if supporting information to justify mitigation credit for items has been sufficiently demonstrated to the District.

36. Any mitigation credit generated by the planned mitigation activities described herein shall only be eligible for use as compensation to offset tidal, saltwater or estuarine wetland impacts associated with projects proposed by Broward County. Use of such mitigation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the mitigation credit.

37. Early transplanting of seagrass from the impact site to the proposed seagrass creation areas shall be voluntary and shall not be subject to survival criteria. However, the recruitment and coverage criteria specified in this permit shall apply.

38. No modifications to this permit shall be required for construction methodology variations from those described in Exhibit No. 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that District staff concur with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by District regulatory and/or compliance staff.

39. Select mangrove trimming necessary to accomplish the planned mitigation efforts described herein shall be authorized by this permit.

40. Mitigation credit for the designated manatee protection areas shall be granted only after documentation of an agreement, easement or other necessary form of authorization for installation of the manatee protection barriers from the U.S. Army Corps of Engineers has been submitted to the District.

41. Activities associated with the implementation of the mitigation, monitoring and maintenance plan(s) shall be completed in accordance with the work schedule attached as Exhibit No. 21. Any deviation from these time frames will require prior approval from the District's Environmental Resource Compliance staff. Such requests must be made in writing and shall include (1) reason for the change, (2) proposed start/finish and/or completion dates; and (3) progress report on the status of the project development or mitigation effort.

GENERAL CONDITIONS

1. All activities authorized by this permit shall be implemented as set forth in the plans, specifications and performance criteria as approved by this permit. Any deviation from the permitted activity and the conditions for undertaking that activity shall constitute a violation of this permit and Part IV, Chapter 373, F.S.

2. This permit or a copy thereof, complete with all conditions, attachments, exhibits, and modifications shall be kept at the work site of the permitted activity. The complete permit shall be available for review at the work site upon request by District staff. The permittee shall require the contractor to review the complete permit prior to commencement of the activity authorized by this permit.

3. Activities approved by this permit shall be conducted in a manner which does not cause violations of State water quality standards. The permittee shall implement best management practices for erosion and pollution control to prevent violation of State water quality standards. Temporary erosion control shall be implemented prior to and during construction, and permanent control measures shall be completed within 7 days of any construction activity. Turbidity barriers shall be installed and maintained at all locations where the possibility of transferring suspended solids into the receiving waterbody exists due to the permitted work. Turbidity barriers shall remain in place at all locations until construction is completed and soils are stabilized and vegetation has been established. All practices shall be in accordance with the guidelines and specifications described in Chapter 6 of the Florida Land Development Manual; A Guide to Sound Land and Water Management (Department of Environmental Regulation, 1988), incorporated by reference in Rule 40E-4.091, F.A.C. unless a project-specific erosion and sediment control plan is approved as part of the permit. Thereafter the permittee shall be responsible for the removal of the barriers. The permittee shall correct any erosion or shoaling that causes adverse impacts to the water resources.

4. The permittee shall notify the District of the anticipated construction start date within 30 days of the date that this permit is issued. At least 48 hours prior to commencement of activity authorized by this permit, the permittee shall submit to the District an Environmental Resource Permit Construction Commencement Notice Form Number 0960 indicating the actual start date and the expected construction completion date.

5. When the duration of construction will exceed one year, the permittee shall submit construction status reports to the District on an annual basis utilizing an annual status report form. Status report forms shall be submitted the following June of each year.

6. Within 30 days after completion of construction of the permitted activity, the permitee shall submit a written statement of completion and certification by a registered professional engineer or other appropriate individual as authorized by law, utilizing the supplied Environmental Resource Permit Construction Completion/Certification Form Number 0881. The statement of completion and certification shall be based on onsite observation of construction or review of as-built drawings for the purpose of determining if the work was completed in compliance with permitted plans and specifications. This submittal shall serve to notify the District that the system is ready for inspection. Additionally, if deviation from the approved drawings is discovered during the certification process, the certification must be accompanied by a copy of the approved permit drawings with deviations noted. Both the original and revised specifications must be clearly shown. The plans must be clearly labeled as "As-built" or "Record" drawing. All surveyed dimensions and elevations shall be certified by a registered surveyor.

7. The operation phase of this permit shall not become effective: until the permittee has complied with the requirements of condition (6) above, and submitted a request for conversion of Environmental Resource Permit from Construction Phase to Operation Phase, Form No. 0920; the District determines the system to be in compliance with the permitted plans and specifications; and the entity approved by the District in

accordance with Sections 9.0 and 10.0 of the Basis of Review for Environmental Resource Permit Applications within the South Florida Water Management District, accepts responsibility for operation and maintenance of the system. The permit shall not be transferred to such approved operation and maintenance entity until the operation phase of the permit becomes effective. Following inspection and approval of the permitted system by the District, the permittee shall initiate transfer of the permit to the approved responsible operating entity if different from the permittee. Until the permit is transferred pursuant to Section 40E-1.6107, F.A.C., the permittee shall be liable for compliance with the terms of the permit.

8. Each phase or independent portion of the permitted system must be completed in accordance with the permitted plans and permit conditions prior to the initiation of the permitted use of site infrastructure located within the area served by that portion or phase of the system. Each phase or independent portion of the system must be completed in accordance with the permitted plans and permit conditions prior to transfer of responsibility for operation and maintenance of the phase or portion of the system to a local government or other responsible entity.

9. For those systems that will be operated or maintained by an entity that will require an easement or deed restriction in order to enable that entity to operate or maintain the system in conformance with this permit, such easement or deed restriction must be recorded in the public records and submitted to the District along with any other final operation and maintenance documents required by Sections 9.0 and 10.0 of the Basis of Review for Environmental Resource Permit applications within the South Florida Water Management District, prior to lot or units sales or prior to the completion of the system, whichever comes first. Other documents concerning the establishment and authority of the operating entity must be filed with the Secretary of State, county or municipal entities. Final operation and maintenance documents must be received by the District when maintenance and operation of the system is accepted by the local government entity. Failure to submit the appropriate final documents will result in the permittee remaining liable for carrying out maintenance and operation of the permitted system and any other permit conditions.

10. Should any other regulatory agency require changes to the permitted system, the permittee shall notify the District in writing of the changes prior to implementation so that a determination can be made whether a permit modification is required.

11. This permit does not eliminate the necessity to obtain any required federal, state, local and special district authorizations prior to the start of any activity approved by this permit. This permit does not convey to the permittee or create in the permittee any property right, or any interest in real property, nor does it authorize any entrance upon or activities on property which is not owned or controlled by the permittee, or convey any rights or privileges other than those specified in the permit and Chapter 40E-4 or Chapter 40E-40, F.A.C..

12. The permittee is hereby advised that Section 253.77, F.S. states that a person may not commence any excavation, construction, or other activity involving the use of sovereign or other lands of the State, the title to which is vested in the Board of Trustees of the Internal Improvement Trust Fund without obtaining the required lease, license, easement, or other form of consent authorizing the proposed use. Therefore, the permittee is responsible for obtaining any necessary authorizations from the Board of Trustees prior to commencing activity on sovereignty lands or other state-owned lands.

13. The permittee must obtain a Water Use permit prior to construction dewatering, unless the work qualifies for a general permit pursuant to Subsection 40E-20.302(3), F.A.C., also known as the "No Notice" Rule.

14. The permittee shall hold and save the District harmless from any and all damages, claims, or liabilities which may arise by reason of the construction, alteration, operation, maintenance, removal, abandonment or use of any system authorized by the permit.

15. Any delineation of the extent of a wetland or other surface water submitted as part

of the permit application, including plans or other supporting documentation, shall not be considered binding, unless a specific condition of this permit or a formal determination under Section 373.421(2), F.S., provides otherwise.

16. The permittee shall notify the District in writing within 30 days of any sale, conveyance, or other transfer of ownership or control of a permitted system or the real property on which the permitted system is located. All transfers of ownership or transfers of a permit are subject to the requirements of Rules 40E-1.6105 and 40E-1.6107, F.A.C.. The permittee transferring the permit shall remain liable for corrective actions that may be required as a result of any violations prior to the sale, conveyance or other transfer of the system.

17. Upon reasonable notice to the permittee, District authorized staff with proper identification shall have permission to enter, inspect, sample and test the system to insure conformity with the plans and specifications approved by the permit.

18. If historical or archaeological artifacts are discovered at any time on the project site, the permittee shall immediately notify the appropriate District service center.

19. The permittee shall immediately notify the District in writing of any previously submitted information that is later discovered to be inaccurate.

40E-4.321 Duration of Permits

(1) Unless revoked or otherwise modified the duration of an environmental resource permit issued under this chapter or Chapter 40E-40, F.A.C. is as follows:

(a) For a conceptual approval, two years from the date of issuance or the date specified as a condition of the permit, unless within that period an application for an individual or standard general permit is filed for any portion of the project. If an application for an environmental resource permit is filed, then the conceptual approval remains valid until final action is taken on the environmental resource permit application. If the application is granted, then the conceptual approval is valid for an additional two years from the date of issuance of the permit. Conceptual approvals which have no individual or standard general environmental resource permit applications filed for a period of two years shall expire automatically at the end of the two year period.

(b) For a conceptual approval filed concurrently with a development of regional impact (DRI) application for development approval (ADA) and a local government comprehensive plan amendment, the duration of the conceptual approval shall be two years from whichever one of the following occurs at the latest date:

1. the effective date of the local government's comprehensive plan amendment.
2. the effective date of the local government development order.
3. the date on which the District issues the conceptual approval, or
4. the latest date of the resolution of any Chapter 120.57, F.A.C., administrative proceeding or other legal appeals.

(c) For an individual or standard general environmental resource permit, five years from the date of issuance or such amount of time as made a condition of the permit.

(d) For a noticed general permit issued pursuant to chapter 40-E-400, F.A.C., five years from the date the notice of intent to use the permit is provided to the District.

(2)(a) Unless prescribed by special permit condition, permits expire automatically according to the timeframes indicated in this rule. If application for extension is made in writing pursuant to subsection (3), the permit shall remain in full force and effect until:

1. the Governing Board takes action on an application for extension of an individual permit, or
2. staff takes action on an application for extension of a standard general permit.

(b) Installation of the project outfall structure shall not constitute a vesting of the permit.

(3) The permit extension shall be issued provided that a permittee files a written request with the District showing good cause prior to the expiration of the permit. For the purpose of this rule, good cause shall mean a set of extenuating circumstances outside of the control of the permittee. Requests for extensions, which shall include documentation of the extenuating circumstances and how they have delayed this project, will not be accepted more than 180 days prior to the expiration date.

(4) Substantial modifications to Conceptual Approvals will extend the duration of the Conceptual Approval for two years from the date of issuance of the modification. For the purposes of this section, the term "substantial modification" shall mean a modification which is reasonably expected to lead to substantially different water resource or environmental impacts which require a detailed review.

(5) Substantial modifications to individual or standard general environmental resource permits issued pursuant to a permit application extend the duration of the permit for three years from the date of issuance of the modification. Individual or standard general environmental resource permit modifications do not extend the duration of a conceptual approval.

(6) Permit modifications issued pursuant to subsection 40E-4.331(2)(b), F.A.C. (letter modifications) do not extend the duration of a permit.

(7) Failure to complete construction or alteration of the surface water management system and obtain operation phase approval from the District within the permit duration shall require a new permit authorization in order to continue construction unless a permit extension is granted.

Specific authority 373.044, 373.113 F.S. Law Implemented 373.413, 373.416, 373.419, 373.426 F.S. History—New 9-3-81, Amended 1-31-82, 12-1-82, Formerly 16K-4.07(4), Amended 7-1-86, 4/20/94, Amended 7-1-86, 4/20/94, 10-3-95

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

3301 Gun Club Road, West Palm Beach, Florida 33406 • (561) 686-8800 • FL WATS 1-800-432-2045 • TDD (561) 697-2574
Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680 • www.sfwmd.gov

CON 24 - 06
Environmental Resource Regulation Department

PRE- AND DURING CONSTRUCTION REQUIREMENTS:

- Permit conditions require these forms to be completed and submitted to District staff within specified time frames.
- These forms are provided to the **PERMITTEE ONLY**, as the entity responsible to satisfy permit conditions, and not his or her agent.

CONSTRUCTION COMMENCEMENT NOTICE
(Form No. 0960)

- For Environmental Resource / Surface Water Management Permits
- Submit within 30 days of permit issuance.
- If dates are not known, notify the District in writing to avoid post-permit compliance action; submit form once dates are determined. Be sure to reference both the application number and permit number on any correspondence.

ANNUAL STATUS REPORT FOR SURFACE WATER MANAGEMENT SYSTEM
(Form No. 0961)

- For Environmental Resource / Surface Water Management Permits
- Submit yearly from the date of construction commencement if construction exceeds one (1) year.

(Rev 6/02)

Projects in the following counties should respond to the corresponding SFWMD Service Center:

Broward, Highlands, Miami-Dade, Martin, Monroe, Okeechobee, Palm Beach, and St. Lucie Counties:
Please respond to the West Palm Beach Service Center.

SFWMD
Environmental Resource Compliance Division
MSC 4230
P.O. Box 24680
West Palm Beach, FL 33416-4680

(561) 686-8800; (800) 432-2045

Charlotte, Collier, Glades, Hendry, and Lee Counties:
Please respond to the Ft. Myers Service Center.

SFWMD
Environmental Resource Compliance Division
MSC 4720
2301 McGregor Blvd.
Ft. Myers, FL 33901

(941) 338-2929; (800) 248-1201

Orange, Osceola, and Polk Counties:
Please respond to the Orlando Service Center.

SFWMD
Environmental Resource Compliance Division
MSC 4710
1707 Orlando Central Parkway, Suite 200
Orlando, FL 32809

(407) 858-6100; (800) 250-4250

(Rev 6/02)

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Environmental Resource/Surface Water Management Permit Construction Commencement Notice

FORM 0960
08/95

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Field Engineering Division

PROJECT NAME: ______________________ PHASE: ____________

I hereby notify the South Florida Water Management District Field Engineering Division that construction of the surface water management system, authorized by Environmental Resource/Surface Water Management Permit No. ____________ under Application No.__________ has commenced/is expected to commence on __________ 199___ and will require a duration of approximately ______/months ______/weeks ______/days to complete. Should the construction term extend beyond one year, I will submit Form No. 0961, Environmental Resource/Surface Water Management Permit Annual Status Report for Surface Water Management System Construction, to the District.

PLEASE NOTE: If the actual construction commencement date is not known, District staff should be so notified in writing. This will eliminate the necessity of further post permit compliance action concerning satisfaction of the Permit condition.

____
Permittee's or Authorized Agent's Signature

____
Title and Company

____
Phone

____
Date

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Environmental Resource/Surface Water Management Permit Annual Status Report for Surface Water Management System Construction

FORM 0961 08/95 **(Required whenever construction duration exceeds one (1) year)**

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Field Engineering Division

PERMIT NO. ____________________ APPLICATION NO. ______________
PROJECT NAME: ____________________ PHASE: ______________

Control Structure(s)	% of Completion	Date of Anticipated Completion	Date of Completion
________	________	________	________
________	________	________	________
________	________	________	________

Benchmark Description (one per major control structure): ______________________
____
____

SWM Facilities	% of Completion	Date of Anticipated Completion	Date of Completion
Lake(s)________	________	________	________
Ditch(es)/Swale(s)________	________	________	________
Exfiltr. Trench________	________	________	________
Dry Area(s)________	________	________	________
Berm(s)________	________	________	________
________	________	________	________

______________________ ______________________ __________
Print Name Phone Date

______________________ ______________________
Permittee's or Authorized Agent's Signature Title and Company

May-03-04 03:25P PORT EVERGLADES-CM&P 9547655389 P.06

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
3301 Gun Club Road, West Palm Beach, Florida 33406 • (561) 686-8800 • FL WATS 1-800-432-2045 • TDD (561) 697-2574
Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680 • www.sfwmd.gov

CON 24 - 06
Environmental Resource Regulation Department

POST-CONSTRUCTION REQUIREMENTS
For projects remaining under single ownership

CONSTRUCTION COMPLETION / CONSTRUCTION CERTIFICATION (Form No. 0881)

- For Environmental Resource / Surface Water Management Permits
- Submit within 30 days of construction completion
- A Florida registered professional engineer must certify that all surface water management system facilities are constructed in substantial conformance with plans and specifications approved by the District
- Required by Sections 373.117 and 373.419, Fla. Stat.
- If another certification form is used by the engineer, it must address all components of the surface water management system
- Statement that all permit conditions are satisfied

(Rev 6/02)

Projects in the following counties should respond to the corresponding SFWMD Service Center:

Broward, Highlands, Miami-Dade, Martin, Monroe, Okeechobee, Palm Beach, and St. Lucie Counties:
Please respond to the West Palm Beach Service Center.

SFWMD
Environmental Resource Compliance Division
MSC 4230
P.O. Box 24680
West Palm Beach, FL 33416-4680

(561) 686-8800; (800) 432-2045

Charlotte, Collier, Glades, Hendry, and Lee Counties:
Please respond to the Ft. Myers Service Center.

SFWMD
Environmental Resource Compliance Division
MSC 4720
2301 McGregor Blvd.
Ft. Myers, FL 33901

(941) 338-2929; (800) 248-1201

Orange, Osceola, and Polk Counties:
Please respond to the Orlando Service Center.

SFWMD
Environmental Resource Compliance Division
MSC 4710
1707 Orlando Central Parkway, Suite 200
Orlando, FL 32809

(407) 858-6100; (800) 250-4250

(Rev 6/02)

South Florida Water Management District

ENVIRONMENTAL RESOURCE / SURFACE WATER MANAGEMENT PERMIT
SURFACE WATER MANAGEMENT SYSTEM
CONSTRUCTION COMPLETION CERTIFICATION

FORM 0881A
09/2003

ENVIRONMENTAL RESOURCE COMPLIANCE DIVISION

PERMIT NO.________________ APPLICATION NO(s).________________

PROJECT NAME: ________________ PHASE: ________________

The subject surface water management system has been designed, constructed and completed as follows (check all that apply):

DISCHARGE STRUCTURE(S) Please provide the requested information for all permitted discharge structures. Attach additional sheets if needed.

Structure Identification Number: ________________
☐ **Weir:** width ________ crest ________
☐ **Bleeder:** type ________ dimensions ________ invert ________

☐ Additional discharge structure information attached.

RETENTION/DETENTION AREA(S): Please provide the requested information for all permitted retention/detention areas. Attach additional sheets if needed.

Retention/Detention Area Identification Number: ________ Size (acres) ________

Side Slope (h:v) ________

☐ Additional retention/detention area information attached.

☐ **EXFILTRATION TRENCH** – Confirmation of cross-section with pipe size and invert, trench width, height and length is provided on the attached.

☐ **CONVEYANCE SYSTEM ONLY** - The components of the permitted surface water management consist of inlets, pipes or other form of conveyance system. Confirmation of ditches, canals, and/or swales with cross-sections, pipe diameters, inverts, and lengths is provided on the attached.

Please indicate the location of the benchmark(s) used to determine the above information on the record drawings (40E-4.381(1)(f), F.A.C. Code). All elevations should be according to National Geodetic Vertical Datum (NGVD). ________

____

I HEREBY NOTIFY THE DISTRICT OF THE COMPLETION OF CONSTRUCTION OF ALL THE COMPONENTS OF THE SURFACE WATER MANAGEMENT FACILITIES FOR THE ABOVE REFERENCED PROJECT AND CERTIFY THAT THEY HAVE BEEN CONSTRUCTED IN SUBSTANTIAL CONFORMANCE WITH THE PLANS AND SPECIFICATIONS PERMITTED BY THE DISTRICT. [A COPY OF THE APPROVED PERMIT DRAWINGS IS ATTACHED WITH DEVIATIONS NOTED, IF APPLICABLE.]

Engineer's Signature, Seal and Date:

Please Print or Type:
Engineer's Name________________
Company Name________________
Address________________
____
Authorization No. of Engineering Business (if applicable): ________
Telephone Number ________________
E-mail ________________

APPENDIX E-3

Mitigation Requirements Analysis for Impacts to Hardbottom Resources

Mitigation Requirements Analysis for Hardbottom Resources Associated with Port Everglades Harbor Navigation Improvements

U.S. Army Corps of Engineers

NOAA – National Marine Fisheries Service

JULY 2014

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1 INTRODUCTION

The Jacksonville District U.S. Corps of Engineers (Corps) is presently completing a feasibility study in part to evaluate the widening and deepening of the Outer Entrance Channel (OEC) of Port Everglades Harbor (Broward County, Florida). The proposed project would impact offshore marine biological resources, including reef communities offshore of the port. The Corps followed with an additional mitigation requirement analysis utilizing the "Visual HEA" software package developed by the National Coral Reef Institute (NCRI) (Kohler and Dodge, 2006).

The Corps conducted a modified Habitat Equivalency Analysis (HEA) using a 0% discount rate, in compliance with OMB Circulars and Corps regulations and guidance. There was significant disagreement between the Resource Agency "Core Group" and the Corps's science staff regarding the input parameters into the HEA, and a result, all inputs into the Corps' modified HEA are based on peer reviewed literature. The analysis conducted by the Corps in October 2013 determined that Component 1 requires 23.21 acres of mitigation; Component 2 requires 10.13 acres of mitigation; Component 3 requires 7.99 acres of mitigation and Indirect Impacts require between 1.13 and 0.59 acres of mitigation depending on the implementation of the direct components.

After completion of the analysis of the required mitigation in October 2013 resulting in the mitigation values cited above, the Corps and the National Marine Fisheries Service coordinated on a joint, "hybrid" mitigation plan. The Corps and NOAA staff worked together on a hybrid mitigation plan that joined artificial reef as originally proposed by the Corps, similar to the artificial reef currently being constructed at the Port of Miami for unavoidable impacts to reef habitats similar to those at Port Everglades and NOAA's preferred mitigation alternative which consists of nursery propagation and outplanting of regionally appropriate coral species. This plan consists of placing a minimum of 5-acres of artificial reef with relocated corals at a density of 1.4 corals/m^2 from the impact site and the outplanting of nursery-propagated corals to areas in Broward County in need of restoration due to vessel grounding or other impacts. Visual HEA was used to calculate the required values for both the artificial reef and the propagated corals.

2 THE ROLE OF HABITAT EQUIVALENCY ANALYSES

Compensatory mitigation is intended to replace the ecological services that are lost as a result of unavoidable impacts to resources affected by a given project. "Ecological services" refer to the services performed by a resource for the benefit of other resources or the public. The baseline for quantifying lost ecological services is the full complement of services that would have been provided absent project implementation. Lost ecological services are quantified as the reduction in the provision of services below this baseline. Compensatory mitigation must restore services commensurate with the character of lost services. The *amount* of compensatory mitigation needed to replace lost services depends, in part, on the ability of the affected resources to return to their baseline conditions. Factors relevant in that regard include the quantity of the affected resources and how fast and how completely they return to their baseline conditions. The amount of compensatory mitigation also depends on the ability of the selected compensatory mitigation measures to replace lost services. Relevant factors for replacement include how fast the compensatory mitigation measures become fully functional and the relative degree to which they provide additional ecological services. An HEA takes into account the above factors, and can be used to determine the appropriate quantity of compensatory mitigation (King 1997).

Habitat equivalency analysis is specifically designed to determine the compensation the public is due to reconcile injuries to the ecosystem and the lost services the ecosystem provides to the biotic component. King (1997) noted "when injured resources and/or services are primarily of indirect human use the appropriate basis for evaluating and scaling the restoration is HEA." The HEA method is specifically used in cases of habitat injury when the service of the injured area is ecologically equivalent to the service that will be provided by the replacement habitat. This approach is termed "service-to-service" (Strange 2002) and assumes the public is willing to accept a one-to-one trade-off between the service lost and the service gained by the restoration (National Oceanic and Atmospheric Administration, or "NOAA" 1997). Of course, HEAs are, by necessity, simplified representations of very complex ecosystems.

Multiple types of injuries can be quantified in an equivalent manner through the use of HEA (Dunford *et al.* 2004). For marine environments, the HEA method has been successfully applied to vessel groundings on coral reefs (Milon and Dodge 2001) and seagrass damage cases (Fonseca *et al.* 1998; Fonseca *et al.* 2000). When this approach is used for scaling losses of fish, birds, and other wildlife, the method is sometimes termed resource equivalency analysis (REA). REA is a resource-to-resource method that references the number of organisms lost and gained. NOAA has recently used the REA method to scale injuries to coral resources related to vessel groundings within the Florida Keys National Marine Sanctuary (FKNMS) by evaluating the losses to stony corals and not the entire habitat affected. Additionally, REA lacks the extensive background and legal review that HEA has undergone. A similar approach was employed by the National Coral Reef Institute (NCRI 2003) for a cable injury to hardbottom resources in the vicinity of Hillsboro Inlet in Broward County.

HEA has also been used in other policy contexts involving the loss of ecological services. For example, it is widely used in natural resource damage assessments conducted under the Oil Pollution Act of 1990 (33 U.S.C. 2701 *et seq.*) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601 *et seq.*).

3 HEA THEORY AND METHODOLOGY

King and Adler (1991) first described habitat equivalency analysis as a methodology for scaling compensatory mitigation under Section 404 of the Clean Water Act. A more recent description of the methodology can be found in Allen, Chapman, and Lane (2005). Briefly, HEA calculates compensatory mitigation so that the total quantity of ecological services it provides is sufficient to offset the total quantity of lost ecological services resulting from the project impacts. When quantifying ecological services, it is important to note that they have a temporal dimension as well as a geographic dimension (e.g., a given area of coral habitat provides beneficial services over a period of time). Therefore, ecological services are quantified in HEA as units of measure, such as acre-years. An acre-year refers to all the ecological services provided by one acre of habitat for one year. For example, 100 acre-years of services might be provided by a 5-acre habitat over a period of 20 years, or by a 10-acre habitat over a 10-year period. This characterization captures not only the important aspect of the physical size of a resource, but also the time interval during which functions are provided.

This measure ("acre-years") of ecological services is obviously habitat-specific, as different habitats provide different services. Therefore, it is important to select compensatory mitigation measures that provide replacement services that are comparable to the lost services (i.e., in-kind replacement). If that is not possible, some meaningful adjustment must be made to equate the replacement services to lost services.

Another important consideration in the quantification of services is time preference. In general, many people prefer present resource uses over future uses for a variety of reasons (such as uncertainty and impatience). This time preference is important when considering how to balance lost and replacement services that occur at different times, since their tradeoffs vary through time. Therefore, the quantities of ecological services occurring at different times are not valued on an equivalent basis and must be adjusted before they can be compared in a meaningful way. This adjustment process, known as discounting, permits one to examine quantities occurring at different times on a comparable basis. The adjustment involves decreasing future quantities and increasing past quantities each year by a proportional amount, known as the discount rate. Discounting, in this context, is analogous to a bank's calculation of compound interest for a deposit or loan. The common time period to which all lost and replacement ecological services are discounted for sake of comparison is known as the present time period.

Through this process of quantifying and discounting ecological services, HEA takes into account losses and gains that occur over different timeframes to determine a scale of compensatory mitigation that is commensurate with the type, level, and duration of lost services. Because HEA accounts for all these important aspects, different compensatory mitigation projects will generally have different scales. For example, a compensatory mitigation project that becomes fully functional in five years will have a smaller indicated scale than one that requires ten years to become fully functional. Therefore, it is important that the compensatory mitigation projects selected for analysis be chosen carefully. HEA is not used to select compensatory mitigation projects, only to determine their scale.

The public is considered fully compensated for ecological losses when the scale of restoration needed to offset losses of resources and services is achieved. HEA establishes the discounted service acre-year as the "common currency" for comparison of the public's value of past injury and future restoration in a common time frame (Julius 1999). One service acre-year is defined as the ecological service provided by one acre in one year. Economic discounting is used to express past injury and future restoration units in a common time (Julius 1999). So, one discounted service acre-year (DSAY) is the service provided by one acre in one year "discounted" to net present value. Area of injured habitat, percent loss of ecological services, duration of injury, are considered in HEA to determine DSAYs.

Cumulative DSAYs earned for a particular restoration project are dependent upon the type of habitat that is restored, the increases in habitat services offered as a result of restoration construction, and the amount of time over which services are provided by the restored habitat. The DSAYs earned over the duration of the restoration project are then translated to present time using a 0% discount rate (see discussion of selection of discount rate below) per THE CORPS and Office of Management and Budget regulations and guidance for Federal water resource development projects. Because the Corps is required to apply a 0% discount rate to HEA, the outputs from Visual HEA for this analysis are referred to as SAYs instead of DSAYs since they are not discounted.

Two different methods of calculating HEA exist, Landscape and Population HEA (Milon and Dodge, 2001). Landscape HEA is most appropriate when the impacted habitat is relatively uniform landscapes with little difference in biological functions across the injured area, this is the method historically employed by NOAA. Examples include injuries to coral reef (Juliuis, et al, 1995), and seagrass (Zieman, 1997) environments in the Florida Keys National Marine Sanctuary. Population HEA may be considered where the total injury area is characterized by a variety of organism groups with different life histories (i.e lifespan). The Population HEA is calculated using the proportional cover of the different groups that make up the community. This results in a recovery time for the population of the group(s) chosen for HEA analysis.

4 TECHNICAL APPROACH FOR PORT EVERGLADES HEA

4.1 USACE Involvement in Two HEA Study Efforts

In addition to the HEA performed by the Corps, the Corps convened a panel of invited experts (a.k.a. "Core Group") from the Resource Agencies and Academia on a number of occasions between November 2006 and November 2007 to assist in using HEA to determine the quantity of mitigation that would be required for this project. The panel met with the Corps to determine the necessary HEA input parameters and to run the HEA. Consensus as to which values to use for the various input parameters was never achieved between the panel and the Corps science staff. Disparate parameters included everything from the discount rate to recovery projections. Accordingly, the outcome of these meetings resulted in the Core Group and the Corps performing a number of HEAs using a wide variety of input values. The extreme upper limits for required compensatory mitigation were calculated with input values assigned by the Core Group, while the outcomes presented in this report were calculated with input values selected by the Corps. The Corps input values for these HEAs were based peer-reviewed scientific literature, *in situ* field conditions and quantitative measurements, local project knowledge and expertise, and assumptions regarding best management practices during project implementation (construction). The HEA analysis was conducted by Dr. Steven Thur (NOAA-Office of Response & Restoration) at the request of, and using values proposed by the Corps. After determining that discount rates should not be applied to Federal water resource development projects per Office of Management and Budget Circulars A-4 and A-94 (Regulatory Analysis and Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, respectively), when federal agencies are determining costs and benefits, the Corps reran the HEAs utilizing the NCRI "Visual HEA" software package. Screenshots of the input parameters and annualizer table results for the resulting HEAs from Visual HEA are included as Appendix A to this report. All assumptions developed by the Resource agency team regarding function of impact sites and mitigation sites were incorporated into these analyses, where applicable. Where the agencies and the Corps disagreed on an input parameter, the Corps' parameter was chosen and input into the model. All of the assumptions from the September 2007 HEA workshop and the final meeting notes from that workshop are included in this report as Appendix B. Determination of resource impacts was based on an overlay of the most recent impact footprint provided in GIS shapefile format from the Corp's Engineering Division on top of the 2008 Broward County Laser Airbome Depth Sounder (LADS) survey. This shapefile was overlaid on the Walker *et al* (2007) dataset from FLDEP's SEFCRI program and the impacts to each of identified habitat types were calculated by hand tracing each of the depth contours. Use of the 2008 in a slight decrease to the impacts associated with the project from the previously used 2001 LADS survey, likely due to the higher resolution of the newer LADS dataset.

4.2 Type of HEA Used for Analyses

For the purpose of the Port Everglades HEA, the method employed by the Corps uses a Landscape HEA with stony corals as the representative proxy for the entire habitat affected. While stony coral coverage is <1% in the project footprint and vicinity (Gilliam *et al.* 2004, DC&A 2009), we did not use a proportional analysis to calculate the coral impacts. Instead, the losses are calculated as the amount of time it would take for the slowest-growing members of the ecosystem, in this case the stony corals, to recover to baseline, for the entire project footprint. Therefore, it is assumed that all other functional attributes of the system (octocorals, sponges, calcareous algae, mobile fauna, etc.) will recover to baseline in less time. This landscape HEA is an extremely conservative estimate of the recovery for the entire ecosystem and therefore, is the most appropriate method for scaling the required compensatory mitigation for impacts from a large-scale project such as the proposed Port Everglades feasibility study.

When comparing the two types of HEAs, the rationale previously used by NCRI (2003) for using a Population HEA to assess the anchor cable damage associated with cable damage in a hardbottom habitat located north of Port Everglades was that "State agencies have indicated they feel the presence of hard coral, soft corals and sponges to be equally important." However, because the recovery projections for both octocoral and sponge assemblages (15 years) are more rapid than stony corals, the NCRI (2003) method underestimates the value of the benthic resources at the landscape scale, and therefore, was dismissed as a viable method for the Port Everglades evaluation.

4.3 Characterization of Hardbottom Resources in Proposed Impact Area

Due to the significant level of disagreement between the Core Group and the Corps, we believe it is necessary to clearly delineate the basis for the impact assumptions used by the Corps in our mitigation assessment using a modified HEA.

Hubbard (2001) noted the importance in distinguishing between "true reefs" and "isolated stands of coral that may be ephemeral in nature and shift from spot to spot." Therefore, understanding the precise meaning of the term as it pertains to the biology and geology of the submerged resources of the southeast Florida shelf is essential and necessary for determining the input parameters necessary to accurately perform this HEA. Outstanding reviews on the "coral reef" problem can be found in Buddemeier and Hopley (1988), Hubbard (2001), and Kleypas et al. (2001), among others. Specifically, Buddemeier and Hopley (1988) stated: "as a minimal definition of a potential reef-building community, we specify that it must contain a significant and robust population of the major classes of reef-building organisms (e.g., framework building corals) and must be capable of developing average community calcification rates that permit vertical and/or lateral accretion." Following this premise, Kleypas et al. (2001) noted that, for a coral community to be a reef, its "[$CaCO_3$] accumulation must exceed zero to meet the most common definitions of a coral reef. The local coral-algal community must be responsible for most of the carbonate addition to the reef..." These conventions have been adopted in recent coral reef classifications such as ReefBase (McManus and Vergara 1998), which distinguishes between coral reefs and non-reef building communities that contain some living coral.

Literature indicates that the offshore hardbottom ridges and terraces in Broward County may not be true coral reefs. The northward extension of the "Florida Reef Tract" to areas north of Fowey Rocks (Miami) was first proposed by Shaler (1890). While noting that individual colonies of stony corals were present north of Fowey Rocks, Vaughan disputed this "reef" interpretation based upon a series of investigations (Vaughan 1914, 1916, 1918, 1919a, 1919b). Vaughan specifically noted that: (1) the main reef building coral species of *Acropora palmata* and *Orbicella annularis* (*Montastraea annularis sensu stricto*) were essentially absent from areas north of Fowey Rocks due to cold-water limitations; (2) Fowey Rocks was the northernmost limit of constructional bank reefs that built their structures to sea level; and (3) while there are some living reef corals in the vicinity of and to the north of Fowey Rocks, there was no thriving reef. It was precisely the fact that there were no living reefs north of Fowey Rocks that limited Vaughan's reef investigations to south of that latitude and not the contrary view that reefs were always there but he just overlooked them due to a lack of rigorous sampling. The fact that Vaughan's reported northern limit to reef growth in Florida to be at Fowey Rocks has been repeatedly validated by numerous reef scientists, is a testament to his keen observational skills.

Using sparker profiles, Duane and Meisburger (1969a, 1969b) identified a number of linear "drowned reef-like features" and "low reef-like ridges that run parallel to shore" that were suggestive of reef buildups. They identified these ridges as "barren;" however, they did not study the biology of the communities living on these ridges and were very careful not to call these structures contemporary, living coral reefs. They used an abbreviated term "reef-line" to graphically depict the progressive reef-like ridges in their bathymetric profiles and plan view map. The term "reef-line" of Duane and Meisburger (1969a, 1969b) was used strictly in a geomorphic sense. In a larger, more regional geologic study that included extensive biological sampling of these submerged ridges, Macintyre and Milliman (1970) commented "The lack of active reef-framework construction on this ridge and the presence of deeper reef fauna (such as alcyonarians, sponges, and scattered coral heads) give this feature the surface characteristics of a submerged reef or drowned reef...However, this ridge cannot be considered a submerged reef because it is well within the depth range (<20m) for the vigorous growth of reef building corals." Macintyre and Milliman (1970) used the term "inactive coral reef" to describe the benthic community found on the ridges between Palm Beach and Fort Lauderdale. They also noted, at the time of their study, that "data are insufficient to speculate on the age or specific mode of accretion (of these ridges)." Soon thereafter, in a master's thesis that focused on the recent sedimentology of the nearshore environments of Broward County, Raymond (1972) described the three parallel hardgrounds (reefs) off Fort Lauderdale as "primarily dead reef rock with an impoverished community of hard corals." At approximately the same time, Goldberg (1973) studied the ecology of the three shore-parallel submarine terraces that stretch from Miami to Palm Beach. Goldberg (1973) stated "...the exact nature of these structures is not known. They may be coral reefs, or they may consist of a recent coral veneer overlying Pleistocene beachrock. For the purposes of this paper, the term 'reeflike ridges' will be abbreviated and the term 'reef' will be used where physiographically applicable." Careful reading of these scholarly works does not support the use of the term *reef* in a biological sense. In fact, these authors were careful to not call these true reefs and qualified the usage of the term.

In the 1970s, a series of offshore wastewater outfalls was constructed in south Florida. These man-made trenches provided an unprecedented opportunity to study the internal structure, architecture, and reef facies of the relict ridges on the southeast Florida shelf (Lighty 1977, 1985; Shinn *et al.* 1977; Lighty *et al.* 1978, 1979). These studies revealed, for the first time, a glimpse into the Holocene history and the environments north of Fowey Rocks. Shinn et al. (1977) briefly described "an almost continuous unnamed 'fossil' reef... that extends northward to at least Palm Beach..." Lighty (1977, 1985; Lighty *et al.* 1978, 1979) studied this outer ridge in the vicinity of Hillsboro Inlet in Broward County. Lighty (references above) described a spectacular, relict shelf-edge barrier reef system dominated by massive wave-resistant growth forms of fossil *Acropora palmata*. Samples of collected *A. palmata* taken from within the trench were radiocarbon dated. These corals ranged in age from 7,145 $\pm$ 80 to 9,440 $\pm$ 85 (uncorrected) years before present (BP). Lighty (1977) used these dates to mark the end of active reef growth on this third terrace in Broward County. He states "the shallow-water reef 'died' about 7,000 years ago and there has been no active reef-framework accumulation since that time." Lighty (1977), discussing the distribution of the modern fauna living on this outer ridge, highlighted the fact that "although this is shallow enough for vigorous coral growth [there is an] apparent absence of several tropical coral species, including *A. palmata* on the present surface of the relict reef." By combing the Holocene history of this reef structure, with the depauperate nature of its present living epifaunal biotic community, Lighty (1977) concluded this early-to-middle Holocene age fossil reef to be "inactive," following the terminology in Macintyre and Millirnan (1970).

In a recent detailed study of the Broward County ridges, Banks et al (2007) characterized the area as, "The Holocene shelf-edge and mid-shelf reef/ridge complex extending along the continental coast of SE Florida from Biscayne Bay northward to offshore of Riviera Beach in northem Palm Beach County, a distance of 128 km." The location of these reefs identifies them as a distinct and also presently non-accreting reef tract (Macintyre 1988) and although previous studies have stated that they are a continuation of the Florida Keys reef tract (Goldberg 1973; Toscano and Macintyre 2003), there has been no confirmation of this. The growth of corals on the Florida Keys reef tract is generally considered to terminate at Fowey Rocks (Vaughan 1914; Jaap 1984; Shinn et al. 1989). Lighty (1977), Lighty et al. (1978, 1982) suggest 14C ages for the outer reef of the northem, continental complex as between 8,000 and 11,000 cal BP [calibrated 14C age in years before present (Toscano and Macintyre 2003)]. The demise of the reefs has been variably attributed to cold counter-current water from the north, a major influx of sediment-rich water originating from the south during the Holocene transgression (Macintyre and Milliman 1970; Lighty et al. 1978; Macintyre 1988), low water temperatures during the early Holocene (Lighty et al. 1978)." This work further confirms the relict (fossil) nature of the terraces (ridges) but says nothing about the ephemeral benthic living resources that are present on the upper surface of the hardbottom.

In the 1980s, a series of papers was published describing the conditions favorable for coral reef development in south Florida. One of these was a community profile report by Jaap (1984), in which he noted that, "the region of maximum coral reef development is restricted to south and west of Cape Florida..." In specifically addressing the area from Palm Beach to Miami (Cape Florida), he stated, "elements of the tropical coral reef biota become increasingly important in a north-to-south gradient; however, the building of three-dimensional reef structures does not occur. This area is characterized as an octocoral-dominated hardground community." Dodge (1987) also noted, "In general, southeast Florida reefs are considered to be 'relict' or fossil structures which are not in an active growth mode, but which are now veneered by a variety of living organisms. The area has been characterized as an octocoral-dominated hardground community (Goldberg 1973, Jaap 1984)." Furthermore, the South Atlantic Fisheries Management Council classified the benthic habitat throughout Broward County as a "hardbottom," where that term constitutes a group of communities characterized by a thin veneer of live corals and other biota overlying assorted sediment types. Hardbottoms are usually of low relief and many are associated with relict reefs, where the coral veneer is supported by dead corals (SAFMC 1998). More recently, a synoptic survey was published by Moyer et al. (2003) where they noted, "The reef-like ridges are a relict (no active accretion due to exceedingly low cover of reef builders)." In ground-truthing these benthic habitats, Moyer et al. commented that, "scleractinian coral cover was low in all areas (and) colony size is small..., and that, alcyonarians were typically the most important faunal group in determining community structure." In addition, Precht and Miller (2006) noted the following:

> "...coral reefs in the Florida Keys that are typically described as the ones in need of salvation represent only a fraction—about 2%—of the total coral habitat in the Florida Keys. These are the shallow spur-and-groove locations that, until recently, were dominated by *A. palmata* and *A. cervicornis*, and they are the reefs that kept pace with rising sea level through the Holocene; they are the named reefs on nautical charts. The other 98% of coral habitat in the Keys are vast stretches of shallow and deep hardbottom habitats characterized by low hard-coral cover, variable but often-high algal cover, and variably abundant gorgonians and sponges. Many of these habitats have probably changed very little over the last 20 years (and possibly much longer), but monitoring programs do not typically include such sites in their studies."

These hardbottom coral communities that have been described throughout the Florida Keys National Marine Sanctuary are similar in composition and make-up to the offshore hardbottom resources found within the project area in Broward County.

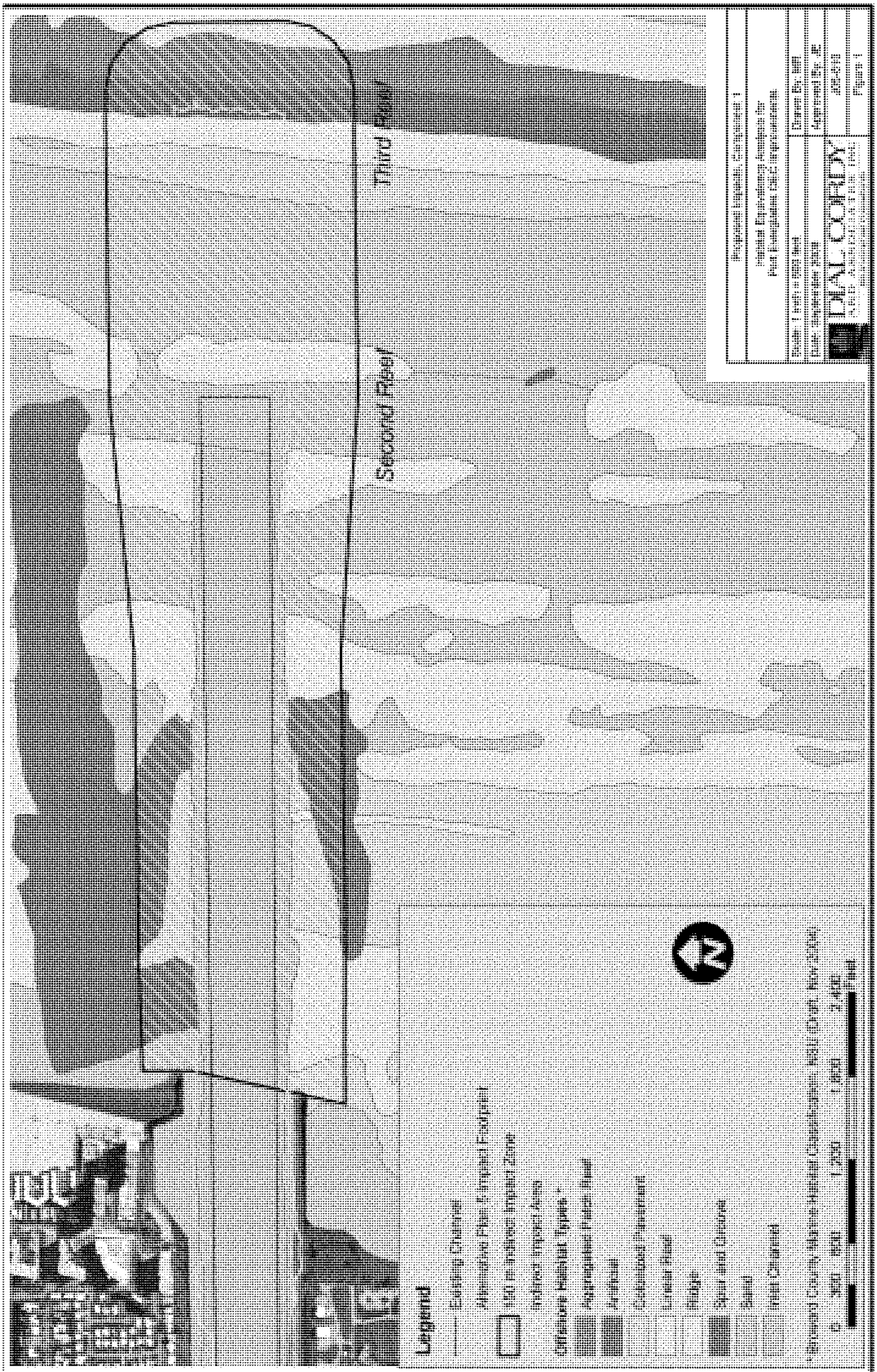
Climate change is an important determinant of the distribution of high-latitude reef systems. Under current scenarios of global warming, the continued, rapid northward expansion of *Acropora*-dominated reefs in the western Atlantic is a strong possibility and we cannot discount the possibility of acroporid coral thickets moving progressively northward (Precht and Aronson 2004). On the other hand, the negative effect of global climate change through increased sea surface temperatures may be evidenced in the project area through (1) coral bleaching, (2) disease-induced stress resulting in morbidity and mortality of the corals and other biota, and (3) direct physical impacts from hurricanes and tropical storms. It should be noted, however, that within the context of HEA recovery projections, there is no allowance for a "shifting baseline" caused by changes in the condition of the reference community due to these or other factors into the future.

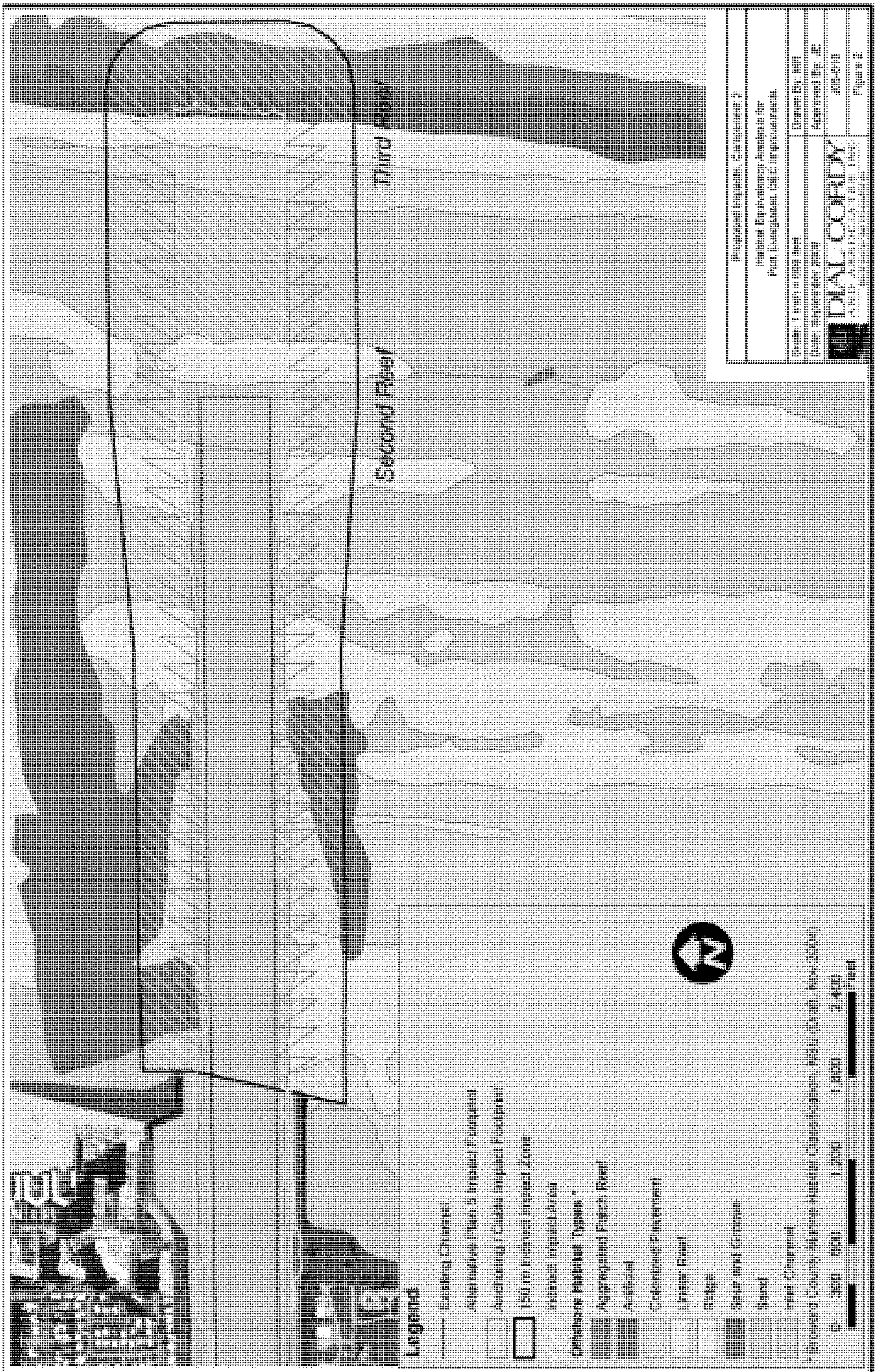
In addition to the intrinsic depauperate nature of the benthic resources both within and outside of the proposed project area, these coral communities are also subject to on-going natural and human disturbances. These disturbances include the negative effects of both hyper- and hypothermic stress; acute heavy wave action during hurricanes and storms; chronic turbidity, siltation and sedimentation associated with terrigenous runoff; sediment resuspension; low salinity caused by freshwater inputs; nutrient availability from sewer outfalls; seasonal algal blooms related to upwelling; low abundance and diversity of herbivores (echinoids and fish); overfishing; physical impacts caused by recreational boat anchoring and by slack ship towing cables that scrape the seafloor and major grounding of large vessels (Vaughan 1916; Goldberg 1973; Rogers 1990; Telesnicki and Goldberg 1995; Szmant 2002; Moyer *et al.* 2003; Gilliam *et al.* 2004; Precht and Aronson 2004; Paul *et al.* 2005; Jaap *et al.* 2006). These disturbances, both separately and in combination, are responsible for the way these communities appear and function today.

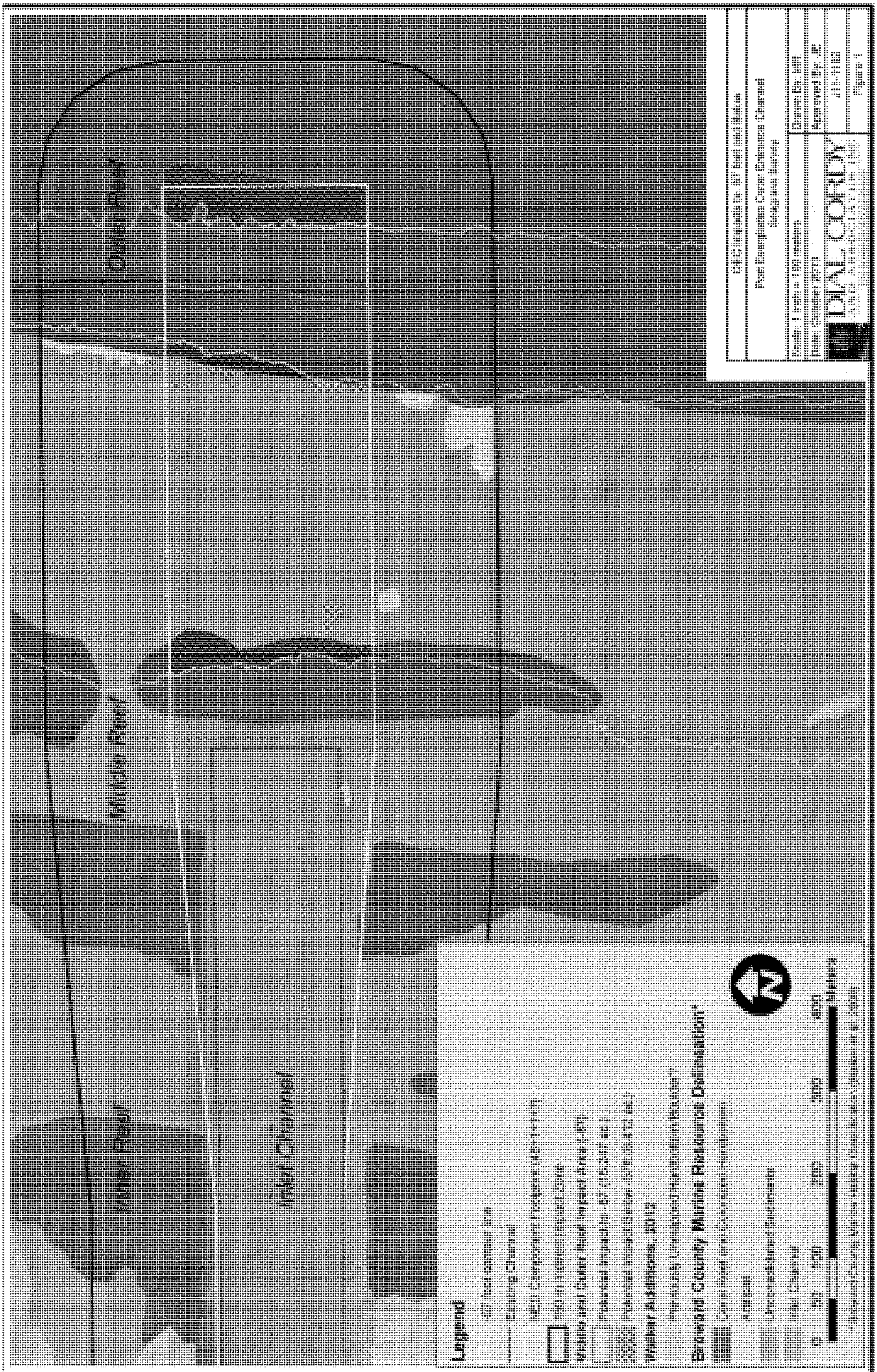
The above discussion of the diminished present condition of the benthic community, compared to its former condition millennia ago, however, is not meant to diminish its present or future value in terms of socio-economic services and resource use. It is intended to be used as a guide for developing an accurate baseline for determining the scale and scope of ecosystem service losses expected as a result of implementation of the proposed Port Everglades navigation improvements, and determining sufficient compensation to the public for damage to affected natural resources.

4.4 Quantification of Biological Impacts

To carry out a detailed impact analysis, and subsequently determine suitable compensation, an understanding of the spatial arrangement of live-bottom resources near the port is necessary. The reef complex offshore of Broward County comprises three, north-south oriented, parallel tracts in waters ranging from approximately 25 to 70 feet deep. The three reef tracts are alternatively referred to (depending on source of information, i.e., historic or recent literature or study) as the "inner," "middle, and "outer" reefs, or the "first," "second", or "third" reef, respectively. Hence, the "outer" or "third" reef refers to the reef tract furthest from shore. Various researchers have also found it useful to refer to the first, second, and third reefs as "Reef 1," "Reef 2," and "Reef 3," particularly when designating sample stations (i.e., R1, R2, R3). The footprint for the proposed Port Everglades OEC widening and deepening includes impacts to sections of the middle reef (or Reef 2) and the outer reef (or Reef 3) off Broward County (see Figures 1, 2 and 3).


Third Reef
Second Reef
Legend
DIAL CORDY


Second Reef
Third Reef
Legend
Existing Channel
Alternative Plan 5 Impact Footprint
Anchoring / Cable Impact Footprint
150 m Indirect Impact Zone
Indirect Impact Area
Offshore Habitat Types *
Aggregated Patch Reef
Artificial
Colonized Pavement
Linear Reef
Ridge
Spur and Groove
Sand
Inlet Channel
0 300 600 1,200 1,800 2,400 Feet
DIAL CORDY


Outer Reef
Middle Reef
Inner Reef
Inlet Channel
Legend
Broward County Marine Resource Delineation
DIAL CORDY

As discussed above, the communities that occupy the middle and outer reefs are dominated by octocorals and sponges and support relatively few scleractinians that are generally small in size (Moyer *et al.* 2003; Gilliam *et al.* 2004; DC&A 2009). Findings of the baseline survey conducted by the Corps for the Port Everglades feasibility study (DC&A 2009), along with the support of various other literature, primarily guided the quantification of interim losses (i.e. injury to biota resulting in decreased services) associated with the proposed construction plans.

The baseline survey mapped the benthic habitats and assessed population levels of hardbottom communities (sessile organisms and reef fish) offshore of Broward County on the middle (Reef 2 or R2) and outer reefs Reef 3 or R3) that may be directly and indirectly impacted by improvements to Port Everglades. A summary of methods and results excerpted from the report follows (the report text, figures, and appendices of that report should be consulted for details (Appendix D of the EIS), including those regarding the precise positions of sampling stations):

> "During February and March 2006, a total of 41 sampling stations among distinct 13 sampling areas (zones) were assessed on the two reef tracts furthest from shore. Sample areas included areas both within and adjacent to the proposed OEC improvements. Benthic organisms were assessed using underwater videography and *in situ* visual observation by divers. Individual belt transects were 10 meters (m) long and 1 m wide for the *in situ* visual assessments, and 10 m long and 40 centimeters (cm) wide for video transects. The dimensions of the belt transects were based on methods applied to coral habitats in Florida and the Caribbean province (e.g., Loya 1976; Rogers et al. 1983; Liddell et al. 1984; Aronson and Precht 1995). Parameters used to characterize the benthic organisms from visual surveys included scleractinian (hard coral) species diversity (*H'*), species richness, and colony density. *In situ* data collected for octocorals and sponges were taken to the lowest possible taxonomic level. Videographic surveys yielded information on the percent cover of scleractinians, octocorals, hydrocorals, macroalgae, turf algae, unconsolidated sediments, and rubble on the seafloor. Species richness was also evaluated from the videographic transects. Fish censuses included stationary counts and counts conducted along belt transects. These censuses provided data regarding fish species richness, abundance, and size.
>
> "Analyses of collected data indicated many differences between the biota of the outermost and middle reef tracts. Middle reef (i.e., second reef, or "Reef 2") sites (in zones R2-Z1 and -Z2) were depauperate in live benthic cover and high in sediment cover compared to outer reef (i.e., third reef, or "Reef 3") sites (in zones R3-Z1, -Z2, and -Z3). Outer reef sites were more developed biologically, as they supported greater hard coral colony densities, coral cover, and octocoral colony densities (these findings support those of Gilliam et al. 2006). The analyses of the data collected for this study corroborated Gilliam et al.'s (2004) assessments of the differences between middle and outer reef benthic communities.
>
> "Outer reef (i.e., third reef, or "Reef 3") zones R3-Z1, -Z2, and -Z3 are located within the proposed (OEC) expansion area. Site substrates at the Third Reef locations consisted of hardbottom, rubble, rocks, pockets of coarse and fine sand, and few artificial substrates. Less than 3% of the scleractinians observed at the Third Reef had some form of bleaching or coral mortality (species most affected were *S. siderea* and *S. intersepta*). Overall, sampling sites in zones R3-Z1, -Z2, and -Z3 supported more developed benthic communities than middle reef (i.e., R2) sites."

Study data summarized above were used to inform assumptions that were used in the quantification of ecosystem losses that may be directly (or indirectly) caused by the widening and deepening of the OEC. Factors such as hardbottom species composition, percentage of cover and sizes of the species present, other observations (e.g., fish counts), and relevant literature detailed in DC&A (2009) were all considered in the HEAs that were performed the potential impact components.

4.5 Impact Assessment

4.5.1 Direct and Incidental Impacts

The middle and outer reefs will be directly impacted by the lengthening and widening of the OEC. There are three potential direct/incidental impact components. Depending on dredging methodology(ies) chosen by the selected contractor, all three of these Components may occur, or some combination of the three may occur. Mitigation for all of the Components has been determined and will be included in the project costs.

4.5.1.1 Component 1 – Direct Removal of Habitat from the Expanded Channel Footprint to -57ft, Channel Wall Loss and 10% of the Area Below Dredge Depth in the Expanded Channel Footprint

Component 1 (Figure 1) includes direct dredging impacts associated with widening and deepening of the channel, resulting in direct habitat removal (14.618 acres) of the middle and outer reef to the recommended alternative – 57 feet total dredge depth (48+7+1+1 = authorized depth (ft) + required underkeel clearance + required overdredge (ft) + allowable overdrege (ft)) and the widening resulting the loss of the existing community on the channel walls where the channel transects the previously dredged sections of the middle reef. Additionally, 10% of the habitat below dredge depth (.71 acres) is assumed to be incidentally impacted by rubble from the dredging during construction, resulting in 100% loss of this portion of the habitat below dredge depth for the 50 year life of the project. Although these incidental impacts may not occur, depending on dredging methodology, the Corps has included them to ensure the project is being conservative in impact assessment. Component 1 results in 15.328 acres of impact with 100% loss of function.

Table 1 Direct Impacts of Component 1

Impact Type	**Acres Impacted**	**Percent Function Loss**	**SAYs Lost**
Direct Removal R2 & R3 and Existing Channel Walls of R2	14.618	100%	717.111
Impacts from construction rubble moving down-slope	.71 (10% of the 7.078 acres downslope)	100%	34.825
Total Impacts	**15.328**		751.936

<u>Middle Reef</u>

The surface area of the middle reef in the path of the proposed OEC expansion is 5.02 acres, the surface area of the channel walls at the previously dredged middle reef is 0.36 acres and the surface area of the middle reef below dredged depth that may be impacted through dredging rubble falling down the slope is 1.69 acres, 10% of which is assumed to be 100% impacted (0.17 acres). The total area being 100% impacted is 5.19 acres. Based on the mean total live cover at R2 sites, approximately 56.2% of this area supports live cover (DC&A 2009). There is no available quantitative data concerning biotic cover or densities on the channel walls due to safety concerns with placing divers in the active shipping channel, due to Corps safety regulations. As a result, impacts to the channel walls are not characterized separately in this section. For mitigation purposes, the channel walls will be characterized based on the data collected for the middle reef.

Based on colony density estimates at R2 (0.48 colonies/m^2), up to approximately 10,119 scleractinian colonies, 83% less than 10 cm in diameter would be removed from the middle reef under Component 1. Octocoral density at R2 sites averaged 0.34 colonies/m^2. Approximately 7,062 octocoral colonies, 72% less than 25 cm in height, would be removed. The Corps is mitigating upfront for the potential loss of 10% of the downslope impacts, however, based on existing information from previous dredging operations at Port Everglades and Port of Miami, and the upcoming Port of Miami dredging, there is no data to indicate the assumed impacts have occurred in the past or will occur in the future. Although, to ensure the Corps continues to be conservative, the impacts associated with removal of the biota in both the direct and rubble areas are detailed below.

Outer Reef

Under Component 1 the surface area of the section of the outer reef in the path of the proposed OEC expansion totals 10.12 (9.60 direct & .52 below dredge depth potential impacts) acres. Based on mean total live cover at R3 sites, approximately 73% of this area comprises live cover (DC&A 2009). As with R2, the Corps is mitigating upfront for the potential loss of 10% of the downslope impacts, however, based on existing information from previous dredging operations at Port Everglades and Port of Miami, and the upcoming Port of Miami dredging, there is no data to indicate the assumed impacts have occurred in the past or will occur in the future.

Based on colony density estimates at R3 (1.88 colonies/m^2) and direct impact of 10.12 acres, up to approximately 76,834 scleractinian colonies, 86% of which are less than 10 cm in diameter, would be removed from the outer reef. Octocoral density at R3 sites (excluding "previously impacted" and "control" sites) averaged 1.44 colonies/m^2. Approximately 58,956 octocoral colonies, 82% less than 25 cm in height, would be removed from the outer reef.

4.5.1.2 Component 2 – Incidental Impacts Associated with the Use of Cutterhead Dredge and Anchor/Cables Outside of the Channel Boundaries.

Component 2 (Figure 2) is the incidental impacts from anchor and cable impacts associated with the dredging operations. These impacts are limited to just the deployment of a cutterhead dredge. It is possible that these impacts will be avoidable, either by using a different piece of equipment, the contractor's ability to anchor inside the channel itself or, by minimizing the impacts through floats on the cables or by deployment methodologies set by the contractor, which would minimize them to the maximum extent practicable. Detailed information concerning the use of a cutterhead dredge is included in Section 2.9.2.2 of the EIS. Component 2 results in 15.04 acres of impacts to hardbottom and reef habitats outside of the channel footprint due to the use of anchor and cable deployment to dredge with a cutterhead dredge. Component 2 is the only scenario with direct impacts to nearshore hardbottom and first reef habitats. For the purposes of mitigation calculations, these habitats were determined to be equal in habitat value as the second and third reefs, due to the lack of quantitative surveys specific to these areas, even though the peer reviewed literature demonstrates that these habitats are less species rich and have fewer hard corals than the second and third reefs (Moyer *et al* 2003; Gilliam 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012). While the Corps could have chosen other non-site specific surveys in Broward County to serve as proxy for the nearshore hardbottom and inner reef, we choose to use the data from Reef #2 to ensure the most conservative approach is being used for mitigation calculations. The worst-case scenario of total removal of all biota by the anchor-cable system was used for calculating impacts for mitigation requirements and the EIS. The Corps reviewed two previous projects that used a cutterhead dredge with the anchor-cable configurations: 1980 in Port Everglades and 1993 at Miami Harbor. In 1980, the project was monitored for impacts associated with the dredging, and no impacts associated with the use of the cutterhead anchoring system are noted in the final report (CSA, 1981). In the 1993 Miami Harbor Phase I project, the Miami-Dade County Department of Environmental Resources Management (DERM) calculated the area of impact for each anchor/cable point, using a float on the cable to minimize impact, was 0.029 acres. The impacts associated with the traditional deployment of the anchor cable dredging method is only associated with cutterhead dredges. The Corps cannot dictate types of dredging equipment that a contractor may use (per the Competition in Contracting Act), so the potential remains for all of the potential contractors to propose to use a cutterhead dredge with the traditional anchor cable configuration. In an attempt to be extremely conservative regarding potential impacts, the Corps chose not to assume that the float system would or could be used in association with the Port Everglades project. This approach was another effort by the Corps to be conservative in determining the necessary mitigation for the project. Actual levels of required mitigation will be determined based on pre- and post- construction monitoring, should the selected contractor chose to use anchor & cable outside the channel as part of their construction technique.

Table 2 Direct Impacts of Component 2

Impact Type	Acres Impacted	Percent Function Loss	SAYs Lost
Incidental due to Anchor/cable outside of channel boundaries	15.04	100% (for worse-case planning purposes, actual loss will be determined through monitoring)	380.061

__Middle Reef__
The surface area of the middle (second) reef, nearshore hardbottom, inner (first) reef and rubble outside of the channel with proposed to be impacted by cable and anchor impacts totals 11.463 acres. Based on a mean total live cover at R2 (second reef) sites (utilized for the whole area as a mechanism to ensure a conservative approach), approximately 56.2% of this area supports live cover (DC&A 2009). Impact assumptions for this Component assume the worst-case scenario, where the use of an anchor-cable system completely removes all biota from the substrate.

As previously explained, this is not typically the case with this dredging methodology, however, to ensure that the mitigation calculations are conservative; the Corps has opted to assume a 100% loss of function for the purposes of this assessment. Based on scleractinian colony density averaged at R2 (0.48 colonies/m^2), and 11.463 acres of direct impact, approximately 22,268 scleractinian colonies, 83% less than 10 cm in diameter, have the potential to be impacted by the use of anchor and cables outside of the channel from the nearshore hardbottom, rubble areas, inner reef, and middle reef. [According to Edmunds *et al.* (1998), 10 cm corresponds to approximately three years worth of lateral growth]. Octocoral density at R2 sites averaged 0.34 colonies/m^2. Therefore approximately 15,541 octocoral colonies, 72% less than 25 cm in height, would be removed. (For more detailed information on colony survey data, see DC&A 2009.)

Outer Reef
The surface area of the outer (third) reef outside of the channel with potential to be impacted by cable and anchor impacts is 3.576 acres. Based on mean total live cover at R3 sites, approximately 73% of this area supports live cover (DC&A 2009).

As previously explained, this is not typically the case with this dredging methodology, however, to ensure that the mitigation calculations are conservative; the Corps has opted to assume a 100% loss of function for the purposes of this assessment. Based on colony density estimates at R3 sites (excluding previously impacted and control sites) (1.88 colonies/m^2), and 3.576 acres of direct impact, up to approximately 27,159 scleractinian colonies, 86% less than 10 cm in diameter, would be removed from the outer reef. Octocoral density at R3 sites (excluding previously impacted and control sites) averaged 1.44 colonies/m^2. Therefore approximately 20,840 octocoral colonies, 82% less than 25 cm in height, would be removed. (For more detailed information on colony survey data, see DC&A 2009.)

4.5.1.3 Component 3 – Potential Impacts Associated with Rubble Moving from the Dredging Footprint onto the Downslope Footprint Below Dredge Depth.

Component 3 (Figure 3) is the incidental impact to the remaining 90% of the area below dredge depth (6.368 acres), potentially being impacted by rubble falling from the dredging area during construction and rolling down the slope, which were not previously accounted for in Component 1. Component 3 may or may not occur depending on dredging methodology (cutterhead vs clamshell/backhoe) and the actual level of impact will be determined by pre- and post-construction monitoring. As with Component 2, the worst-case, 100% impact assumption was used to calculate the potential mitigation associated with this Component, thus ensuring full funding of the potential mitigation associated with the impacts, however the actual impacts for the Component will be assessed using pre- and post-construction monitoring.

Table 3 Direct Impacts of Component 3

Impact Type	Acres Impacted	Percent Function Loss	SAYs Lost
Incidental due to construction rubble moving downslope	6.368	To Be Determined through monitoring	299.933

Middle Reef
The surface area of the remaining 90% of the middle (second) reef, below dredge depth, which may be impacted by rubble moving downslope that was not mitigated for in advance of project construction is 1.69 acres. Based on a mean total live cover at R2 (second reef) sites (utilized for the whole area as a mechanism to ensure a conservative approach), approximately 56.2% of this area supports live cover (DC&A 2009). Impact assessment for this Component uses the worst-case scenario, where the rubble completely damages the area resulting in 100% loss of the biota remaining on 90% of the substrate.

Based on colony density estimates at R2 sites, which did not survey below dredge depth, (1.88 colonies/m^2), and 1.69 acres of impact, up to 3,290 scleractinian colonies, 86% less than 10 cm in diameter, would be impacted by falling rubble on the middle reef. Octocoral density at R2 sites averaged 1.44 colonies/m^2. Therefore approximately 2,296 octocoral colonies, 82% less than 25 cm in height, would be removed (for more detailed information on colony survey data, see DC&A 2009.)

Outer Reef

The surface area of the remaining 90% of the outer (third) reef, below dredge depth, which may be impacted by rubble moving downslope, that was not mitigated for in advance of project construction is 4.68 acres. Based on mean total live cover at R3 sites, approximately 73% of this area supports live cover (DC&A 2009). Using the colony density estimates at R3 sites, which did not survey below dredge depth (excluding previously impacted and control sites) (1.88 colonies/m^2), and 4.68 acres of impact, up to approximately 12,864 scleractinian colonies, 86% less than 10 cm in diameter, may be impacted from falling rubble during construction of the OEC. Octocoral density at R3 sites averaged 1.44 colonies/m^2. Therefore approximately 27,253 octocoral colonies, 82% less than 25 cm in height, may be impacted. (For more detailed information on colony survey data, see DC&A 2009.)

4.5.2 Indirect Impacts

The Corps proposed the establishment of an "indirect impact zone" extending 150 meters around the proposed OEC footprint. This zone includes many habitat types, including outer, middle, and inner reefs, nearshore hardbottom, and rock/rubble habitat. The 150 meter buffer is based on previous interagency discussions where the agencies agreed that 150 meters was a sufficient distance to monitor for events, a review of two previous navigation projects in southeast Florida (Port Everglades and Key West) where project monitoring showed that sedimentation impacts did not impact adjacent corals along the sides of the navigation channels (CSA 1981; CSA. 2007a; CSA 2007b). Additionally, in recent consultations under Section 7 of the Endangered Species Act the National Marine Fisheries Service for two projects in Miami-Dade County concluded that the effects of sedimentation on the adjacent threatened coral, *Acropora cervicornis*, to be insignificant, as the rates of sedimentation documented in a similar offshore dredging project were within the bounds of sedimentation documented to occur naturally. Finally NMFS concluded that due to this sedimentation rate, and a proposed 400-foot buffer between the dredging area and the threatened corals, the effects on the coral would be "insignificant" (NMFS 2009, NMFS 2011). Additionally, a review of US Environmental Protection Agency (USEPA) monitoring reports for disposal plume at the Port of Miami mapped the plume's travel time and sediment concentration after disposal. USEPA (2008) found that at the time of initial disposal (1 minute post disposal) in the water column, sedimentation levels (surface TSS) concentration ranged from 34 to 77 mg/l. The material disposed in the Port of Miami project is the same type of material being dredged at Port Everglades (hard limestone) and should result in similar conditions regarding associated sedimentation and turbidity generated by the material. Both of these values are much lower than the 200 mg/cm^2/day rate shown to have an impact on the threatened *Acropora cervicornis* (Rogers 1990).

In an effort to be extremely conservative and protective of any resources adjacent to the Port Everglades outer entrance channel, the Corps decided to implement a 150-meter indirect impact buffer for sedimentation impacts, and calculate necessary mitigation for impacts associated with dredging activities that might result in impacts from sedimentation. The 150-meter buffer was developed based on USEPA data for Miami Harbor, as well as FLDEP's standard turbidity monitoring protocol, which requires turbidity levels to return to background within 150-meters for dredging in areas not designated an Outstanding Florida Water, including offshore of Broward County and surrounding Port Everglades. The project will mitigate upfront for a 2% loss of function. This is broken down as 1% during construction, 0.5% for up to 20 years after construction and 0.5% for years 21-50 after construction. Any additional mitigation will be based upon during project monitoring. These calculations are a planning and budgetary tool. Construction is expected to be 11-14 months in duration, however to ensure a conservative approach, the Corps assumed construction in the OEC will last three (3) years.

The 2007 HEA meeting participants originally assumed an increase in vessel calls associated with the expansion of Port Everglades and this increase in vessel calls would have resulted in an incremental increase in the turbidity and sedimentation effects on coral and hardbottom resources adjacent to the channel. Subsequently, the "future with the project" analysis of the Economic Analysis estimates 5,067 vessel calls in 2060, an increase of 1,646 vessel calls into Port Everglades over the 2012 baseline of 4,000 vessel calls, yet 96 lower than the without project estimate of 5,163. Because there are fewer ships arriving at the port in the future with the expansion project, there is not an incremental increase in turbidity and sedimentation associated with the project after construction is complete. There will actually be a decrease in total impacts associated with turbidity and sedimentation due to vessel movements in the channel over the life of the project. However, because this increment of water quality improvement is difficult to assess, the Corps opted NOT to credit the project with the potential water quality improvements over the life of the federal project in a continued effort to be conservative. The only impacts of turbidity and sedimentation assessed for the project will be those directly attributable to construction activities. These changes were incorporated into the necessary mitigation analysis.

Peer reviewed research and monitoring of other projects show that dredging's effects on the environment are equal to or less impactful than storms that move through the ecosystem when it comes to sedimentation effects (CSA 2007; Pennekamp et al 1996). The Corps expects turbidity and sedimentation effects associated with the project to be similar to those seen either (1) during the 2004 and 2006 O&M dredging events of the Key West entrance channel or (2) during the 1980-1981 deepening of Port Everglades (which involved all the same areas as the TSP except the OEC expansion area). In both cases, the habitats adjacent to the channel were monitored for sedimentation and turbidity impacts, and in both cases, no effects directly linked to the dredging were observed or reported (CSA 1981, 2006, and 2007). It should be noted that there were no required sedimentation or turbidity cut off triggers in the 1981 project at Port Everglades. These projects were detailed in Section 4.5.10.2.3 of the EIS.

Despite being visually spectacular (especially by being distinguishable in color from ambient ocean water) the sediment load carried by such turbidity plumes is minimal. As the plume ages it is subject to a cascade of processes, which result in a significant diffusion and dispersion as the plume mixes with ocean currents (Bloetscher et al. 2012). Little supporting evidence exists for increased rates of sediment accumulation at reef sites within or near these turbid plumes (CSA 1981, CSA 2007). There have been no refereed journal publications that directly link impacts on reefs with raised turbidity and/or rates of sediment accumulation associated with these plumes from past port dredging projects in SE Florida.

Erftemeijer et al (2012) specifically commented that the risks and severity of impact from dredging (and other sediment disturbances) on corals are primarily related to the intensity, duration and frequency of exposure to increased turbidity and sedimentation. The sensitivity of a coral reef to dredging impacts and its ability to recover depend on the antecedent ecological conditions of the reef, its resilience and the ambient conditions normally experienced. In the case of the reefs in the vicinity of Port Everglades they are regularly subjected to variable and often high levels of turbidity and sedimentation (Edge et al. 2013) including storms. Craft (2008) noted that adjacent to the Port Everglades area, coral cover was naturally low due to stochastic events such as hurricanes and tropical storms. As such, the coral community is comprised primarily of eurytopic, stress tolerant species (Burman et al. 2012, Darling et al. 2012) thus, minimizing the overall risk of lethal impacts due to dredging.

For the purposes of this analysis, only those impacts that permanently remove habitat via dredging or 10% rubble mobilization are considered direct (Component 1). Incidental impacts are those which are dredging equipment related and may or may not occur depending on dredging methodologies used by the contractor (Components 2 and 3). All other impacts are considered indirect, since they are solely temporal in nature. The amount of indirect impacts differs depending on which of the Components of direct and incidental impacts are actually enacted during project construction. Table 4 lists the amount of indirect impacts that would occur depending on which impact Components are enacted. If an impact is listed as part of a direct component, that impact is subtracted from the indirect effects total.

Table 4 Indirect Effects of Project

Components	Indirect Impacts associated with turbidity and sedimentation during construction (acres) within 150-m of the project area	Functional Loss Calculated in HEA for Required Mitigation	SAYs Lost
Component 1	109.08	2% up front, addtl based on monitoring	42.300
Components 1 & 2	94.04	2% up front, addtl based on monitoring	22.216

4.6 Assumptions for HEAs

4.6.1 Context for Live-bottom Community Impacts and Recovery

The proposed dredging would have direct and indirect effects on the benthic communities and seafloor substrate within and outside of the proposed project footprint. The direct (i.e., construction) disturbance on the middle reef and outer reef caused by the dredging and subsequent removal of biota will be relatively short in duration, but will have an acute effect on the sessile and mobile reef organisms (biological environment), and the seafloor substrate (physical environment). All live cover (including scleractinians, octocorals, sponges, hydrocorals, zonathids, tunicates, and algae) will be removed. The removal of the substrate will cause the loss of the three-dimensional structure and shelter used by sessile and mobile biota. The dredging will also uncover (denude) large open spaces, frequently comprising hard substrates/consolidated surfaces, which will be available for colonization by benthic organisms. Following a major disturbance, colonization of bare substrate typically begins with the recruitment of opportunistic pioneering algae, usually cyanobacteria and some green algae (Jaap 2000). Within one to two years, recruited reef organisms will include crustose coralline algae, sponges, *Pseudopterogorgia* (pioneer octocoral), zoanthids, and scleractinians (pioneer brooding species including *Porites astreoides* and *Agaricia agricites*) (Jaap 2000). Within eight to ten years, a high density of sponges and octocorals can be expected, although scleractinian density will remain somewhat depressed (Jaap 2000). Those scleractinians present will consist mostly of short-lived, highly fecund species such as *Agaricia agaricites*, *Porites porites*, *Porites steroids*, *Favia fragum*, and *Colpophyllia natans* (Hughes 1985; Jaap 2000).

Any ecologically significant recovery of newly dredged substrates may take decades (Maragos 1974; Precht 1998). Major and minor factors associated with the proposed port expansion project that may prevent recovery to pre-injury status include the deepening of the seafloor substrate (major); the removal of reef topographic complexity (major); sedimentation and siltation during the dredging (minor); and the predicted level of sediment resuspension and siltation following dredging operations (minor). It should be noted that after the last Port Everglades expansion project, follow-up monitoring of corals surrounding the impact areas was performed to assess the stress from sedimentation and turbidity. One-year after the completion of the project, no coral mortality or morbidity was observed (CSA 1981). In short, the middle and outer reef areas to be dredged will be subject to unavoidable short-term acute impacts, followed by some minor degree of long-term impacts compounded by existing disturbances.

Any pre- and post-dredging restoration actions (i.e., those that "jump-start" recovery) will be beneficial to habitat recovery because coral growth rates are slow even under optimal conditions, and barren areas have low natural recruitment rates (Jaap 2000). Following the recommendations in Jaap (2000) and Precht and Dodge (2003), the highest priority for restoration action should be the salvage of corals from the direct impact areas and subsequent transplantation, which will accelerate recovery and improve the aesthetic value of the artificial; reef system. Discussing the importance of using these salvaged corals in restoration projects, K. Banks (of Broward County Biological Resources Division) noted "If it takes a reef 50 years to regain its coral community once it's damaged; knocking 10 years off that is gaining a lot" (Wyman 2000). Structural three-dimensional reconstruction can be attained outside the project limits by installing limestone boulders that will provide surface area for coral, sponge, and algae recruits, and provide habitat to fish and lobsters (Jaap 2000; DERM 2004; DERM 2007).

Suspected indirect effects of adjacent dredging and filling activities include sub-lethal effects (injury, decreased fecundity, etc.) on corals due to sedimentation and turbidity. Several biological monitoring studies have documented coral "health" related to adjacent dredging activities or sand placement. Pre-, during-, and post-construction monitoring activities were conducted for the dredging of Key West Harbor (CSA 2007a, CSA 2007b). During that project, project and control sites monitored for bleaching and paling showed similar levels of bleaching and paling. Pre-, during-, and post-construction activities were also conducted for the Broward County Shore Protection Plan (Gilliam *et al.* 2008, Gilliam *et al.* 2006, Gilliam *et al.* 2004, Fisher *et al.* 2011). A seven-year biological monitoring effort documented reef community changes before and during beach nourishment activities in Broward County. Results showed no effect of sand placement activities or dredging of borrow areas on corals or other biological components of adjacent reefs. In sum, the above reports suggest that corals were not measurably affected by adjacent dredging activities or sand placement during and after these activities. This may be because of strict water quality standards implemented by the State of Florida that require construction shut-downs when turbidity levels exceed a pre-determined level.

After the November 2013 meetings between the Corps and NMFS, the following assumptions for the Port Everglades Project were agreed to for all of the credit and debit HEAs prepared. Please note Corps policy constrained the time period for service gains and losses and discount rate, resulting in values for these parameters that NMFS would not recommend for other projects.

4.6.1.1 Start Year: 2017

If the project schedule changes, start and end years would change accordingly, however the time period for service gains and losses would remain the same.

4.6.1.2 End Year: 2067

Corps policy limits the time period for service gains and losses to no more than 50 years based on the 50-year project life set forth in the Corps' Planning Guidance Notebook (ER-1105-2-100; Chpt 2 (4) j; Append D, D-6 a.(3)(a)(2)) which sets the maximum period of analysis at 50 years. Outside these constraints, currently, a period of 100 years has been set by resource agencies for HEAs that examine direct impacts to coral reefs, however this has not been the case for HEAs completed for impacts associated with impacts in Broward County over the last 10-15 years that were reviewed by the Corps during preparation of its original mitigation analysis.

4.6.1.3 Time Period for service gains and losses: 50 years

As stated above, Corps policy limits the time period for service gains and losses. Use of this approach for the credit HEA for reef enhancement, results in reef enhancement beginning in later project years provide less cumulative services to the analysis than reef enhancement completed in earlier years.

4.6.1.4 Discount Rates

When weighing the benefits and costs of coastal restoration projects and other environmental management programs, the selection of a "discount rate" is a key consideration. The discount rate is the rate at which society, as a whole, is willing to trade-off "present" for "future" benefits. In essence, to make past and future losses and gains comparable, a discount rate must be applied. Federal regulations and NOAA (1999 and 2005) recommend using a 3% discount rate when scaling compensatory restoration for discounting interim service losses and restoration gains. NOAA recommends using the social, or consumer, rate of time preference for discounting interim service losses and restoration gains, when scaling compensatory restoration (NOAA 1997; NOAA 2000; NOAA 2005).

When weighing the decision to undertake a project with long-term benefits versus one with short-term benefits and long-term costs, the discount rate plays an extremely important role in determining the outcome of the analysis. High discount rates tend to discourage projects that generate long-term benefits, and favor those that create short-term benefits. Specifically, the discount factor decreases the value of future services and increases the value of past services in order to reflect how much the public values future (or past) service benefits today. This incorporates the assumption that services provided sooner are more highly valued than those provided later (Kohler and Dodge 2006). However, this assumption does not well represent our present society's strong preference to ensure the long-term sustainability of our natural and environmental resources. In other words, they fail to recognize that the concerns/values of future generations are relevant when resource management and policy-making decisions are evaluated (Prager and Shertzer 2006). Hence, many authors have recently recommended capping a discount rate for environmental projects at 1%.

For this analysis, Dr. Thur performed the calculations for the HEAs using the discount rate that is being used by NOAA and other federal agencies for HEAs involving natural resource damages. NOAA does not address the OMB guidance regarding discount rates for Federal water resource development projects. This is calculated by using the federal cost of capital. The generally accepted practice is to apply the effective yield on comparable-term treasury securities. During the 1990s, the average 10-year Treasury bond rate was 6.01%, whereas inflation averaged 2.88%. Thus, the real rate of interest on treasury bonds was roughly 3.13% (Bellas and Zerbe 2003). Alternatively, from 1990 to 2003, real gross domestic product grew by 2.96% (NOAA 2005). Thus, using productivity over that period as the basis of the discount rate also generates an approximate 3.0% rate.

The outcome of the analysis in an HEA is highly sensitive to the discount rate. A high discount rate reduces the benefit-cost ratio, because the costs associated with the restoration project are experienced disproportionately during the first half of the recovery analysis timeframe. Arbitrarily selecting discount rates to meet short-term political goals could have long-term consequences. For example, high discount rates tend to discourage projects with high up-front costs, such as the proposed Port Everglades construction project. However, they also discourage hardbottom and reef restoration programs that may be associated with such projects.

Below are the published discount rates from the White House Office of Budget and Management (Federal Register 73(20), January 30, 2008); note that the federal discount rate is presently lower than the 3% used in the NOAA calculations:

REAL INTEREST RATES ON TREASURY NOTES AND BONDS OF SPECIFIED MATURITIES
[In percent]

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
2.1	2.3	2.4	2.6	2.8	2.8

As previously stated, Under Office of Management and Budget Circulars A-4 and A-94 (Regulatory Analysis and Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, respectively), when federal agencies are determining costs and benefits of a federal water resources development project, *no discounting should occur* (emphasis added). Specifically Circular A-94 states "Specifically exempted from the scope of this Circular are decisions concerning water resource projects (guidance for which is the approved Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies." The Port Everglades Feasibility Study, and all of the components of that study, falls under the aforementioned water resource principles and guidelines.

Additionally, Under Corps Regulations (ER 1105-2-100, Appendix E, Pg E-154), any mitigation plan developed for the Port Everglades Feasibility Study will be evaluated using a Cost Effectiveness/Incremental Cost Analysis (CE/ICA). The regulations for CE/ICA require that the models utilized to determine benefits (or habitat recovery when assessing mitigation) not utilize a discount rate to be in compliance with the OMB guidance documents previously presented. The regulations for CE/ICA require that the models utilized to determine benefits (or habitat recovery when assessing mitigation) not value the same quality habitat less in the future than in the present. While the NOAA HEA utilizes a 3% discount rate, to abide by the OMB guidance for Federal water resources development projects and Corp's regulations for CE/ICA, the modified HEA prepared by the Corps does not utilize a discount rate and for the calculations, 0% will be used and will be referred to as the "modified HEA". The mitigation needs analysis performed by the Corps utilized the Visual HEA software package (Kohler and Dodge, 2006) method utilizing a 0% discount rate. The Corps was unable to replicate Dr. Thur's calculations, as NOAA did not provide spreadsheets with the formulas embedded to the Corps.

The final determination of mitigation required for the project will be determined in coordination between the Plan Development Team, the resource agencies, the Corps' regional and HQ policy offices and finally the office of the Assistant Secretary of the Army for Civil Works.

As previously stated, assumptions developed during the Sept and Nov 2007 inter-agency HEA meetings were utilized for this analysis by the Corps and applied to the artificial reef with coral transplantation HEA scenario. Summary tables from the final meeting notes for each habitat type and scenario, and both summary reports from the two meetings are included in their entirety in Appendix B for reference. The group discussed the parameter values for the outer, middle and inner reef areas for direct impacts and then the three reef areas for the indirect impacts. The tables below show values agreed to in "normal" font. Where there wasn't agreement, options were identified are shown in "*italics*." Each of the impact areas was addressed with a separate analysis. Where the same numbers were agreed to, notations are included (Not all areas of impact were assessed by the HEA team as some have been developed since the 2007 meetings were held).

Since the 2007 HEA meetings, the Corps has revised amount of impacts to the reefs and project area as a result of refined engineering analysis and additional, higher resolution habitat maps; modified project duration due to refined construction timelines and the nature of impacts associated with indirect effects associated with vessel movements in the OEC as a result of the economic analysis. Additional Inter-agency meetings were held in September 2013 and with NMFS in November 2013 and the Corps agreed to change some of the impact numbers associated with the OEC to change impacts from one category of impact to another category of impact (indirect to potential rubble impacts below dredge depth). These changes are noted in Tables 5, 6, 7 by the number being in BOLD and inside parenthesis ().

Table 5 Outer and Middle Reef Direct Impacts, including channel walls (Total Habitat Removal and 100% loss of 10% of Down Slope Habitat by Rubble Impacts)

INJURY			
1. Claim year = Date of Injury	2017	2. Value-injured/value restored=1	1
3. Site name	Outer reef	4. Equilibrium level to which recovery can reach	*0, 5 &**7.5%***
5. Type of injury (direct, indirect+)	Direct	6. Injury recovery time to equilibrium	*50 for 5-15* *0 for 0*
7. # of injured area units	13.54 a **(15.328)**	8. Shape of recovery trajectory=linear	Linear
9. Pre-injury service level =100%	100%	10. Time units=years	Years
11. Degree of service lost of resources immediately following injury (%)	100%	12. Discount rate per time unit (%)	*3 or 6%, **(0%)***

* The middle reef was discussed briefly and everyone agreed to use the same numbers as the outer reef even though the makeup is somewhat different.

Table 6 Indirect Sedimentation/Turbidity Impacts to all Habitats

INJURY			
1. Claim year= Date of Injury	2017	2. Value-injured/value restored=1	1
3. Site name	150m buffer around entire channel	4. Equilibrium level to which recovery can reach	98%
5. Type of injury (direct, indirect)	Indirect sed/turb	6. Injury recovery time to equilibrium – **duration of construction**	35 yrs *15 yrs* **(3yrs; 20 yrs; 50 yrs)**
7. # of injured area units	15.89a **(109.08)**	8. Shape of recovery trajectory=linear	Linear
9. Pre-injury service level	100%	10. Time units=years	Years
11. Degree of service lost of resources immediately following injury (%)	2, 5% **1%; .5%, .5%**	12. Discount rate per time unit (%)	3%, *6%* *(0%)*

Table 7 is a new table created as a result of the September 2013 Inter-Agency Meetings and captures the impacts associated with potential rubble impacts during construction for the remaining 90% of the area below dredge depth. This analysis, like the analysis for the use of anchors and cables associated with the use of a cutterhead dredge is for planning purposes and assures that by capturing this potential equipment dependant impact in project planning and project budget and ensures that should these impacts occur, above the 10% already assumed to be occurring in Component 1 that the necessary funds are there to construct the required mitigation.

Table 7 Rubble Impacts to 90% Habitat Below Dredge Depth

INJURY			
1. Claim year= Date of Injury	2017	2. Value-injured/value restored=1	1
3. Site name	90% of habitat below dredge depth	4. Equilibrium level to which recovery can reach	**(15%)**
5. Type of injury (direct, indirect)	Equipment Incidental	6. Injury recovery time to equilibrium	50yrs
7. # of injured area units	**(6.37)**	8. Shape of recovery trajectory=linear	Linear
9. Pre-injury service level	100%	10. Time units=years	Years
11. Degree of service lost of resources immediately following injury (%)	100%	12. Discount rate per time unit (%)	3%, *6%* *(0%)*

4.6.2 Scaling the Values of Compensatory Actions

In order to determine the action (or funds) required for compensation (mitigation), the scale of restoration was determined by calculating the benefit from a reef mitigation project constructed with boulders. The calculations regarding benefits of this action were divided into two components: (1) boulder emplacement, and (2) transplantation of mature coral colonies from the dredging area onto the constructed boulder-reef. Representative recovery rates were then estimated for both components using a similar boulder mitigation project established for a recent beach nourishment project (Kohler and Dodge 2006). In that analysis, it was assumed that the mitigation boulders would naturally recover to 100% full reef services in 50 years. However, they would recover to 100% full services in *less* time by transplanting corals onto the boulders. A similar rationale and methodology was included in this HEA for the Port Everglades OEC expansion project. For the Port Everglades feasibility study HEA, the recovery timeline was assumed to be 50 years without coral transplantation as a worse-case scenario. This timeframe would be reduced to approximately 30 years with coral transplantation from the impact site.

The Core Group used extremely conservative estimates for the replacement boulder reef mitigation project. This included long recovery times and diminished services compared to natural reef areas. This is again contrary to published literature (Kohler and Dodge 2006, Milon and Dodge 2001) and the results of similar mitigation projects performed in the region. For instance, only five years after implementation, the Bal Harbour Boulder Reef Mitigation Project had yielded the following conclusions from Blair *et al.* (2008):

> "It does appear that the artificial reef structures are providing habitat for diverse benthic and fish assemblages. Benthic assemblages have a moderately high level of similarity to the natural reefs in species composition and relative species representation, which may indicate that the artificial reef materials are developing communities that are comparable to the natural reef areas. Trends identified in the benthic data indicate potential for

continued convergence of the artificial and natural population constituents. Fish assemblages on the artificial reef do share many species in common with the natural reef areas."

The Corps reviewed another compensatory mitigation project associated with a port deepening project in SE Florida to help provide information on what may be expected from a reef boulder mitigation project associated with channel construction; the Corps reviewed the artificial reef constructed for the Miami Harbor's 1991 entrance channel deepening project. Dredging of the channel was completed in 1991 and the artificial reefs were placed in the mitigation sites in 1994 (DERM, 2004). The 1991 deepening project is very similar to the proposed Port Everglades expansion, as it cut through the third reef to lengthen and deepen the channel. The artificial reef site consisted of individual reefs of the following make up:

- Two linear series of "spur" formations each consisting of:
  - Five to six linear rows of limerock boulders with spacing of 50 to 75 feet between each row.
  - Each row is 40 to 60 feet wide, 8 to 10 feet high and 450 to 500 feet long.
  - The footprint of each "spur and groove" formation is estimated to cover approximately 4.2 acres.
- Thirty-six individual oblong "patch reefs" consisting of:
  - An area 80 to 100 feet long, 50 to 60 feet wide and 8 to 10 feet high.
  - Patch reefs were placed on 100 foot centers.
  - The cumulative footprint of the 36: "patches" totals approx. 4.5 acres.

No coral relocation was performed from the impact areas to the artificial reef sites. In the assessment of the reefs performance, DERM took biological characterization data from pre-dredge surveys of impact areas in 1990-1991 and compared the artificial reefs biota to those reports. Species assessed included fish and benthic communities. The age of these communities at the time of the report was nine (9) years. They were constructed between June and November of 1995 and the surveys for this report were completed in 2003. A summary table of the results of the Miami Channel surveys in 1991 and the POM-B artificial reef boulders is included below (DERM 2004; DERM 2007).

Table 8 Miami Harbor Pre-Dredge Survey vs 2003 Mitigation Survey

4.6.2.1.1.1.1.1 Taxonomic Group	**1991 Pre-Dredging # Taxa**	**POM A # Taxa**	**POM B # Taxa**
Algae	Not Noted	5*	5*
Anemone	Not Noted	1	0
Bivalve	1	2	2
Bryozoan	Not Noted	1	2
Corallimorph	Not Noted	1	0
Echinoderm	1	2	0
Hard Coral	18	18	25
Hydroid	Not Noted	1	1
Hydrocoral	Not Noted	1	1
Soft Coral	8	1	14
Sponge	9	27	28
Tunicate	Not Noted	6	4
Zoanthid	Not Noted	0	0
TOTALS	**37**	**61**	**77**

The Miami Channel was characterized by 37 different biotic non-fish species. The boulder reefs at Site POM-B were characterized by 77 species, with taxonomic groups not seen in the channel being present on the reefs. Hard coral species richess increased by 28%; octocoral species richness increased by 43%. Over species richness of the boulder reefs was 52% higher than the channel that was impacted. An additional survey was conducted by DERM in 2007 in association with a Florida Fish and Wildlife Conservation Commission grant. This study looked at percent coverage of each functional habitat group.

4.6.2.1.1.1.1.2 Functional Group	**POM A % cover**	**POM B % cover**
Algae	79.90	76.54
Scleratinia	3.57	4.04
Milleporidae	0.42	0.38
Octocorallia	4.83	11.73
Porifera	10.49	5.14
Ascidaria	0.00	0.11
Zoanthidae	0.04	0.04
Other live	0.49	0.23

For the Port Everglades HEA, using the assumption of similar boulder reef construction, in water depths similar to the third and second reef impact areas (like in Miami) and assuming an extremely conservative colonization rate and functional equality timeframe of 50 years based on the input from the inter-agency team for boulder reefs without coral transplants and 30 years for boulder reefs with coral transplants. However, if we limited ourselves to the information from the

Miami Harbor artificial reef reports in 2003 and 2007, which is the most comparable mitigation project to what is being proposed for Port Everglades, a timeframe of 10 years may be more appropriate. At this time, the Corps plans to continue with the timeframes agreed to in the 2007 inter-agency meetings in lieu of the shorter timeframes demonstrated at the Miami Harbor artificial reef.

During the November 2013 meetings with NMFS, NMFS presented additional information, which indicated that the assumed recovery level of 90% utilized by the Corps for boulder reefs might be higher than would actually be demonstrated in the wild. The Corps provided NMFS with monitoring data from the Port of Miami boulder reefs showing significant colonization of this boulder reef with the same coral and soft coral species as seen at the Port of Miami impact area prior to the deepening of that channel. There was no transplantation of any organisms to the rocks after placement at the reef site. The Corps believes that this is the best representation of the potential of the proposed artificial reefs for Port Everglades. NMFS was unable to provide a response to why this artificial reef appeared to outperform other artificial reefs it reviewed. However, to err on the side of conservatism and abide by the precautionary principle, the Corps agreed to consider that artificial reefs constructed of boulders with transplanted corals would have a different recovery rate than those without transplanted corals.

4.6.3 Recovery Rates

An assessment of how long it would take resources subject to each injury type to fully recover was conducted by determining the trajectory of the recovery over time. These recovery trajectories depend on the species of coral affected, the type and degree of injury, any primary restoration to be implemented, and the type of environment in which the injury occurred. Data from literature and field observations and best professional judgment were used to inform values for these parameters. While the successions of most coral reef ecosystems follow the law of sigmoidal growth, a linear recovery trajectory was used for all HEAs performed in this report. This is common industry practice and includes most HEAs performed to date for marine resource valuations that deal with corals.

Observations of reef injuries from vessel groundings in the FKNMS informs biologists of the importance of providing restoration actions (such as installation of "starter" colonies, or re-attaching injured colonies), in concert with natural recovery of impacted areas, in order to "jump-start" recovery rates. Although some compensatory ecological value can be attributed to naturally recovering live-bottom habitats, simply using only that as compensation is not practicable due to the amount of time that would be required for a community to fully recover to pre-impact conditions from an uncolonized substrate (Precht *et al.* 2001; Shutler *et al* 2006; Piniak *et al.* 2006). The application of a recovery rate of 70 to 100 years for such a situation would result in lower service gains (hence rendering such compensation as essentially impracticable) because service gains per year (and cumulatively) are so heavily discounted (S. Thur, NOAA, pers com), i.e., the value of incrementally provided services so far into the future would be of little value.

Under optimum conditions, overall coral reef growth rates are slow (0.65 to 4.85 m/1000 yr, or 2 to 16 ft/1000 yr according to Shinn *et al.* 1977). However, some studies have documented decadal-scale recovery after the coral reef system experienced moderate disturbance (Jaap 2000). To date, most HEAs that have been performed on coral habitats in Florida have used recovery projections that vary between 15 and 75 years; most average between 35 and 50 years. In the past, for practical purposes, NOAA generally has used a 50-year recovery projection for most coral injuries within the FKNMS (S. Shutler, FKNMS, pers com) while the State of Florida typically has used 35 years for coral injuries in Broward County (W. Jaap, University of South Florida, pers com). While in Miami-Dade County, resource economists have used a 43-year projection for recovery for coral injuries within Biscayne National Park (B. Peacock, Biscayne National Park, pers com). Unfortunately, many of these approximations for recovery projections used in previous HEAs have been based on little evidence and, therefore, are not defensible from a quantitative standpoint. Hence, it is imperative to use all available scientific information to develop accurate recovery projections for the resources in the project footprint and surrounding environments. For example, in specifically addressing impacts in Broward County, NCRI (2003) noted the following:

> "... it is recognized that there are some, but very few, corals which are older than 35 years. Inspection of size-frequency curves from other similar locations on the middle and outer reefs indicates that by far the majority of coral specimens present are younger than 35 years. This recovery time has been used for the Broward County beach renourishment HEA to determine the amount of compensatory restoration. It was also used for the USS Memphis submarine grounding case as well as for settlement purposes in other injuries in Broward County involving hard corals."

Using the demographic history of coral populations for Broward's stony corals, a "50-year recovery" to pre-disturbance baseline conditions is an appropriate metric for most injury conditions (W. Precht, unpublished data) were transplantation of corals onto the mitigation site does not occur. Moyer et al. (2003), NCRI (2003), Gilliam *et al.* (2004), and DC&A (2009) discussed the relatively small size of the coral species present within the project area. Using published average growth rates and measured sizes (~25 cm) of the five most common species in the project area, an average recovery rate of approximately 50 years was calculated (Table 9). Therefore, a linear 50-year recovery trajectory for use in HEAs is both reasonable and scientifically defensible. From a similar analysis, using the average growth rates and sizes of the largest (i.e., ≤ 40 cm) species recorded in the project area, a similar value resulted (approximately 50-year recovery projection). Recovery projections in excess of 50 years for most Broward County hardbottom communities, such as those proposed throughout the Core Group's HEA, are not consistent with the known growth rates and life history strategies for the impacted species within the project footprint, nor are they consistent with previous HEAs developed for the second and third reefs as described above (see NCRI 2003). While there are some long-lived, centuries-old *Montastraea annularis* species complex corals within Broward County, none were found in the project area. As such, using these corals as a template for recovery projections for this project is not defensible. Furthermore, it should be noted that there are some injury types, as well as habitat types, that have recovery times that are in the range of only 35 years. For instance, the well-established coral communities that are presently observed on the walls and lip of the existing channel entrance to Port Everglades have developed in less than 30 years, the length of the interval since the last channel widening operation. Finally, many corals found within the project area have life expectancies that are <50 years (e.g. *Porites astreoides*; see Kissling 1977) further supporting the use of the conservative 50-year recovery value.

In practice, recovery rates can be attenuated below the 50-year mark by limiting sedimentation, siltation, and turbidity during dredging; and salvaging and transplanting scleractinian corals from the impact site to the mitigation site. Actual recovery rates of both the impacted area and the mitigation site should be accessed through a dedicated, long-term monitoring program that evaluates the effectiveness of the mitigative measures by assessing the functional attributes of sessile and mobile reef organisms (Precht and Aronson 2006).

Table 9 Coral Growth Rates of Most Common Species Observed in the Project Area

Siderastrea siderea	2.2 to 7.1 mm/yr Avg = 4.65	Vaughan 1916, Landon 1975, Jaap 1984, Huston 1985, Torres and Morelock 2002
Stephanocoenia intersepta	< 8.0 mm/yr	Shinn et al. 1989
Porites astreoides	2.3 to 5.0 mm/yr Avg = 3.65	Kissling 1977, Gladfelter et al. 1978, Huston 1985, Torres and Morelock 2002
Montastraea cavernosa	3.6 to 6.8 mm/yr Avg = 5.2	Weber and White 1977, Huston 1985
Siderastrea radians	< 3 mm/yr Avg = 1.5	Vaughan 1916

Table 10 Coral Growth Rates of Largest Species Observed in the Project Area

Colpophyillia natans	2.2 to 7.1 mm/yr Avg = 4.65	Vaughan 1916, Landon 1975, Jaap 1984, Huston 1985, Torres and Morelock 2002
Stephanocoenia intercepta	~8.0 mm/yr	Shinn et al. 1989
Montrastraea annularis (sc)	4.8 to 11.2 mm/yr Avg = 8.0	Baker and Weber 1975, Dustan 1975, Gladfelter et al. 1978, Hudson and Robbin 1981, Huston 1985, Hudson 1981a & 1981b
Montastraea cavernosa	3.6 to 6.8 mm/yr Avg = 5.2	Weber and White 1977, Ghihold and Enos 1982, Huston 1985
Diploria strigosa	3.5 -10 mm/yr Avg = 6.75	Vaughan 1916, Dodge and Vaisnys 1975, Logan et al. 1994

Because relocation of corals greater than 10cm in size from the middle and outer reef impact areas to the proposed mitigation area is included in the mitigation plan, a decrease in recovery time from 50 years to 35 years was utilized for the assessment where relocated corals are attached to the artificial reef.

4.6.4 Boulders with Coral Transplants

To determine how much area of the five acres of artificial reef would be covered by the proposed transplantation of hard corals from the impact zone to the artificial reef, the Corps calculated the number of hard corals greater than 10cm that would be transplanted from the impact site to the artificial reef, in this case 11,502. Then this was divided by 1.4, the weighted average of the density of the corals in the direct impact site, resulting in 8,215.7 ft^2 of the proposed artificial reef would be covered with corals. Then this value was divided by 4,047 ft^2/acre, resulting in 2.03 acres being covered in corals after the transplantation was complete. This portion of the artificial reef would recover faster than the remaining portion of the artificial reef that did not receive transplanted corals.

Table 11 HEA Inputs for Boulders with Coral Transplants

COMPENSATORY ACTION – Artificial reef w/coral transplants			
1. Date of compensatory action	2017	2. Time for services to develop from installation to equilibrium	65, 55, 50, **35 (with relocation)**
3. Type of compensatory action	Calculate boulders with relocated corals	4. Shape of trajectory to equilibrium services	Linear
5. Pre-restoration service level (%)	Close to 0% **(0%)**	6. Time units=years	Years
7. Service level of compensatory action upon initial installation (of designed boulder placement)	0-5% **(10%)**	8. Discount rate	*3-6% (0%)*
9. Equilibrium level of service from CA expected (for boulders with specified transplants)	75,100% **(90%)**		

After assessing the amount of the boulder reef which would be covered with corals and would be assigned the 90% recovery rate at 35 years, these values were input into Visual HEA and an output of SAYs was determined. The value of the credit SAYs is found in Table 14.

4.6.5 Boulders without Coral Transplants

To determine the amount of remaining artificial reef without corals, the Corps subtracted the acreage with corals transplanted from the total of five acres (5.0-2.03) leaving a total of 2.97 acres. This value was used to determine the credit SAYs found in Table 14.

Table 12 HEA Inputs for Boulders without Coral Transplants

COMPENSATORY ACTION			
1. Date of compensatory action	2017	2. Time for services to develop from installation to equilibrium	65, 55, **50 (without relocation)**
3. Type of compensatory action	Calculate boulders without relocated corals	4. Shape of trajectory to equilibrium services	Linear
5. Pre-restoration service level (%)	Close to 0% **(0%)**	6. Time units=years	Years
7. Service level of compensatory action upon initial installation (<u>of designed boulder placement</u>)	0-5% **(10%)**	8. Discount rate	*3-6% (0%)*
9. Equilibrium level of service from CA expected (for boulders with specified transplants)	75,100% **(50%)**		

4.7 Assumptions for the HEA for Coral Rescue, Propagation and Outplanting

After construction of five acres of boulder reef, the remaining ~638[1] Service Acre Year's (SAY's) would be mitigated by enhancing degraded reefs near the Port Everglades Project. Enhancement of degraded reefs would be accomplished by attaching (outplanting) regionally appropriate coral and sponge species to reef sites at a density and number commensurate with project impacts. Outplanted organisms would be obtained by collecting corals and sponges from sites where they are unlikely to survive (commonly referred to as "rescued corals" or "corals/sponges of opportunity") or from propagating corals in ocean-based or land-based nurseries. As the outplanted corals and sponges grow and their fragments take hold and expand, the level of ecological services provided by the enhanced reefs is expected to rise yielding a net increase in ecological services that compensates for those lost from expanding the Port Everglades Outer Entrance Channel. While outplanted corals and sponges will improve structure and function of the degraded reefs, more importantly the outplanted corals will increase the likelihood of successful sexual reproduction and contribute directly to the pool of coral larvae available to colonize adjacent reefs.

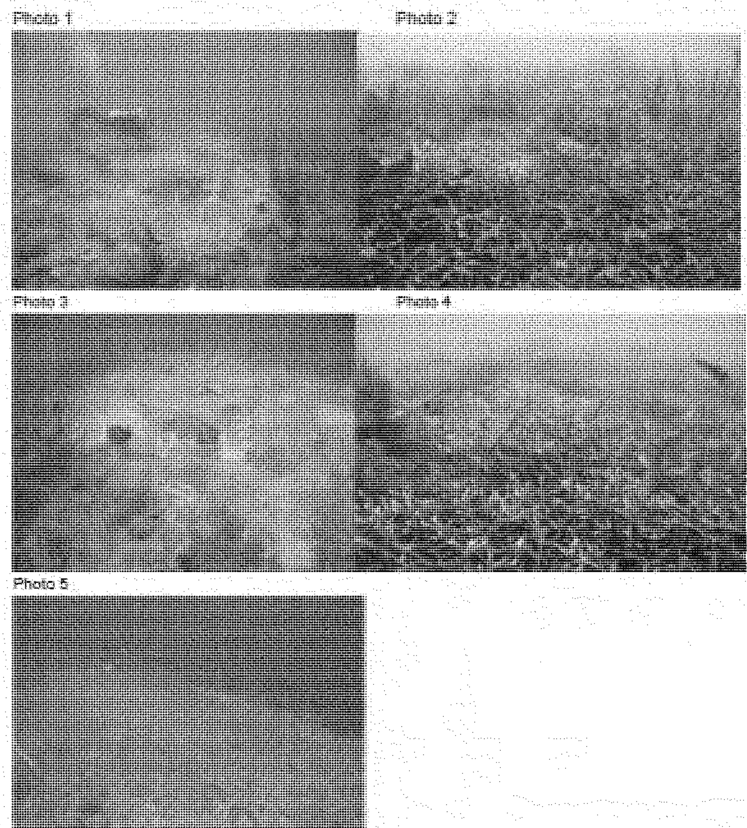
To maximize the return of lost services, the outplanted species would be a regionally appropriate mix of fast and slow growing massive and branching, as well as habitat forming sponges. Slow growing species include massive corals, brooding corals, barrel sponges (*Xestospongia muta*). These slow growing species are needed to achieve a locally appropriate community diversity. Fast growing species include staghorn coral (*Acropora cervicornis*), which has the fastest growth rate among Atlantic/Caribbean coral species, reproduces predominantly via asexual fragmentation, and can be propagated efficiently in ocean-based and land-based nurseries. While replacing coral colonies is an essential component of the reef mitigation, replacing the three-dimensional structure of the reef is also important. *Acropora cervicornis*, in addition to barrel sponges and other species that will be outplanted, will provide significant three-dimensional structure through their normal growth patterns. *Acropora cervicornis* also will provide three-dimensional structure more quickly than other species because of its growth form, fast growth rate, and frequency of asexual fragmentation.

Using rescued and propagated corals to restore impacted and degraded sites has been successful at many locations. Figure 4 shows a site impacted by a vessel grounding in 2006. The site was completely devoid of coral after the grounding. In 2006 and 2007, the site was restored using a mix of stony corals rescued from the impact, clippings and plantings of octocorals sourced from the impact and surrounding reef, and nursery grown *Acropora cervicornis*. At this site, original outplants are still living after seven years, but more importantly, the natural recruitment processes were jump started and resulted in a healthy, genetically diverse coral reef community. While *Acropora cervicornis* is visually dominant in the photograph, the site currently supports a diverse mix of originally planted and subsequently recruited corals. The original restoration site was approximately 50 square meters, and the impact is barely discernible today within that site. Work at this site benefited the surrounding reef as well, increasing increasing coral cover, tissue biomass, reef rugosity, and fish biomass and diversity to an area greater than 300 square meters (personal communication, Dr. Sean Griffin, Coral Reef Ecologist, NOAA Restoration Center, Habitat Restoration Division, 260 Guard Road, Aguadilla, PR, 00605, December 3, 2013).

[1] All numerical references in this section are based on the USACE committing to successfully relocate 11.502 corals at a density of 1.4 corals/m² (2.03 acres of boulder reef). Relocating less corals, will change the number of corals required to outplant upwards.

Figure 4 - Figure #1 from NOAA's Dec 13, 2013 Information Package

Figure 1: Photos 1 and 3 are the sites of a vessel grounding in Puerto Rico while enhancement with rescue and propagation corals was underway in 2006 (pre-outplanting photo not available but would have shown a site similar to what is seen in Photo 5). Photos 2 and 4 are the same site depicted in Photo 1 and 3, respectively in year 2013. Photo 5 is a 2012 photo from the same vessel grounding site shown in Photos 1 through, 4 but at a site where no enhancement work was completed.



HEA Assumptions for the Reef Enhancement Component of the Mitigation

In order to assess the functional benefit of mitigation measures using HEA, it is necessary to develop a trajectory (recovery curve) for achieving the maximum benefits associated with a mitigation action above the existing baseline level associated with the site pre-mitigation[2]. In order to develop the recovery curve for the Port Everglades Project, presence, size, and growth

[2] Sites targeted for mitigation have varying degrees of baseline services and are degraded relative to natural reefs in the project area; however all have the ability to regain a significant amount of service function as a result of the reef enhancement mitigation action.

of target organisms were used as a proxy for reef service level. The increase in services from time of mitigation implementation to achieving the 90% level above baseline (considered the 0.00 service level for purposes of calculating gains above a varied baseline) is not assumed to be linear because the corals utilized to enhance the mitigation site grow, and thereby considered to increase service value, at different rates[3]. As discussed above, the proposed mitigation project would use a mix of slower growing and faster growing organisms.

4.7.1.1 Initial Services

Upon initial outplanting (year 1; 2017), the mitigation site is assumed to achieve a 10% increase in services above baseline. This increase of services includes the reef substrate and initial plantings of the full suite of regionally appropriate species.

4.7.1.2 Services after Initial Expansion and Colonization

After 10 years (year 10, 2027), it is expected the mitigation sites will achieve an additional 55% services. This contribution is largely due to use of faster growing corals that are assumed to initially allow the mitigation project to achieve a more rapid return of services during the first 10 years. This rapid accumulation of services is known to occur in natural communities off Broward County (e.g., Walker et al. 2012).

4.7.1.3 Maximum Increase in Services

After 35 years, (year 35, 2052) the mitigation site is assumed to achieve an additional 80% increase in services above the immediately post mitigation service level of 0.10 yielding a maximum recovery level of 90% above baseline. In order to achieve this, corals that have a high contribution to reef building (e.g., *Montastraea annularis, Montastraea cavernosa, Siderastrea steroid*), medium contribution to reef building (e.g., *Diploria clivosa, Stephanocoenia intersepta*), and other habitat forming reef species (e.g., *Xestospongia muta*) would be outplanted.

4.7.1.4 Total Services

The increase in services above the pre-mitigation baseline reaching a maximum recovery level of 90% above baseline continues for the next 15 years. During this time, the slower growing organisms continue to grow and help increase the value of the site in order to achieve the remaining increases in services over a total of 50 years (year 50, 2067).

<u>Translating HEA Results Into Reef Enhancement</u>

With an understanding of the total Debit SAY's associated with the Port Everglades feasibility study (794.236, Table 10); the total SAY's gained per acre of mitigation (37.525 Reef Enhancement; 31.90 Boulder-based Artificial Reef w/transplants; and 15.50 Boulder-based Artificial Reef without transplants; Table 15); and the preferred mix of mitigation (5 acres of Boulder-based Artificial Reef with 2.03 acres of the five acres enhanced with transplants and the remainder addressed through the reef enhancement mitigation project), it is possible to calculate the total compensatory mitigation requirements.

[3] Massive stony corals and slower growing barrel sponges generally have a growth rate of 0.56 cm/year and therefore take longer to provide the same level of services as faster growing corals which have significantly faster growth rates (10 cm to 20 cm annual increase in colony diameter). For massive coral growth rates, see Table 8 in the Characterization of Essential Fish Habitat in the Port Everglades Expansion Area (2011) prepared by NMFS for USACE and included in the DEIS as appendix H. McMurray et al. (2008) report similar (0.52 to 0.65 cm/yr) growth rates from *Xestospongia muta*. In addition, the colony diameter growth rate of *Acropora cervicornis* can vary from ~71 mm/yr to as much ~260 mm/yr (Shinn 1966; Lewis et al. 1968; Gladfelter et al. 1978) and in some regions exceeds 400 mm.

The five acres of boulder-based artificial reef results in a gain of 110.793 SAY's and leaves an outstanding debt of 638.247SAY's to be addressed by the reef enhancement project (depicted in Table 14). With a credit gain rate of ~37.5 SAY's per acre, a total compensatory mitigation requirement of 18.21 acres of reef enhancement. At a rate of 1.4 corals/m^2 this will require 103,191 corals be sourced from corals and sponges of opportunity (rescue corals) or propagated in coral nurseries and then successfully outplanted to mitigation sites. If additional acres of boulder reef are required during permitting, the number of outplanted corals will decrease accordingly.

Table 13 Debit service area years by category of impact

Impact category	Debit SAYs
Component 1 (direct impact, channel walls and 10% below dredge depth)	751.936
Indirect outside of channel	42.30
TOTAL	794.236

Table 14 Credit service area years by category of impact (based on 5-acres of boulder reef)

Mitigation type	Credit SAYs
Boulders only	46.034
Boulders w/ transplants	64.759
Reef enhancement	683.443
TOTAL	794.236

Table 15 Summary of the 3 types of mitigation that compose the blended plan

	Mitigation Type		
HEA Assumption	Boulder Only	Boulder w/ transplants	Reef Enhancement w/ outplants
Start Year	2017	2017	2017
End Year	2067	2067	2067
Time period for service gains and losses	50 years	50 years	50 years
Discount rate	0%	0%	0%
Initial services	10%	10%	10%
Interim (and maximum) services	N/A	90% in 35 years	65% in 10 years (90% in 35 years)
Total services	50%	90%	90%
SAYs (per 1 area unit)	15.5	31.9	37.5

5 RESULTS

Results for the portion of the HEA for the hybrid mitigation plan for all of the individual Components are listed below in Tables 16 through 18 (with more detail is provided in Appendix A). Each table provides the following (left to right in the tables): information regarding reef injury category (location and type of impact), acreage of category-specific impact, anticipated service level at recovery equilibrium (a "100%" value would indicate a complete functional recovery to pre-impact conditions), time interval until equilibrium services are reached, and finally, *discount service acre-years lost* ("SAYs" lost) (see formula, p. 21 of NOAA 2006). DSAYs for anchor and cable impacts (Component 2 shown in Table 17) and impacts associated with rubble moving downslope (Component 3 shown in Table 18), including those on the middle and outer reefs, were calculated at an elevated service-lost rate than the actual injury that is likely to occur (evidence from other projects indicates these impacts are less severe than direct dredging impacts). Calculation at the higher rate ensures that the Corps captures these impacts as contingency in the project authorization, so that SHOULD they occur, the Corps has the resources to respond to them. Although indirect impacts are not anticipated by the Corps, they have been accounted for (using a 98% initial service loss value) in the event of failure of best management practices and any lapse in water quality monitoring efforts during construction.

Table 19 lists the four different indirect impact footprint based on which direct impact components are implemented during construction.

For proper compensation, the service gains attributed to mitigation activities must offset the total service losses attributed to the reef impacts. A convenient way to begin to determine the total "value" of mitigation activities, such as those proposed for this project (i.e., construction of a boulder reef), is to evaluate the gain attributed to a single acre of such an effort. For the project at hand, three categories for reef restoration/replacement were proposed: artificial reef with coral transplantation from the impact site; artificial reef without coral transplantation and outplanting of nursery raised corals and corals of opportunity over a specific acreage with a total number of outplanted corals required. As shown in Table 20, the restoration/replacement categories would provide 10% service initially and either 90% at maturity of 50% at maturity depending on the scenario. Although much of the peer reviewed literature states that the restoration sites gain full function as compared to surrounding habitats or the or the original impact area, to ensure the Corps' assumptions are conservative regarding replacement of lost function, the Corps capped recovery at 90% for the purpose of this analysis. With differing expectations for resulting biota for the two categories of mitigation, the anticipated time to full recovery was different. Calculation details are found in NOAA (2006) and Kohler and Dodge (2006).

Table 16 HEA Input Vales and Calculated Losses for Component 1 Impacts

Injury Category	Area (acres)	Initial Service Loss (%)	Recovery Service Level (%)	Time to Recovery of Impact Site	SAY losses
Middle and Outer Reef Direct Impacts- Recovery to 15% 100% loss of 10% Habitat Below Dredge Depth	15.33	100	15	50	751.936

Table 17 HEA Input Vales and Calculated Losses for Component 2 Impacts

Injury Category	Area (acres)	Initial Service Loss (%)	Recovery Service Level (%)	Time to Recovery (years) with relocation of corals	SAY losses
Incidental Anchor and Cable Impacts- Recovery to 98%	15.04	100	98	50	380.061

Table 18 HEA Input Vales and Calculated Losses for Component 3 Impacts

Injury Category	Area (acres)	Initial Service Loss (%)	Recovery Service Level (%)	Time to Recovery (years) with relocation of corals	SAY losses
Middle and Outer Reef Direct Impacts - 100% loss of 90% Habitat Below Dredge Depth	6.368	100	15	50	299.933

Table 19 HEA Input Vales and Calculated Losses for Indirect Impacts

Injury Category	Area (acres)	Initial Service Loss (%)	Recovery Service Level (%)	Time to Recovery (years)	DSAY losses
Indirect Impacts - 2% loss, perpetual loss (no recovery) – with Component 1	109.08	2	98	3/20/50	26.997
Indirect Impacts - 2% loss, perpetual loss (no recovery) – With Components 1 & 2	94.04	2	98	3/20/50	22.216

Table 20 HEA Calculations for Proposed Compensatory Mitigation

Category of Restoration/Replacement	Area (acres)	Initial Service Gained (%)	Recovery Service Level @ Maturity (%)	Time to Full Recovery (yrs)
1) Created boulder reef with relocated coral for Component 1 impacts	1.0	10	90	35
2) Created boulder reef without relocated coral for Component 1 impacts	1.0	10	50	50
3) Outplanted corals to reef enhancement sites	1.0	10	90	50

The impact and recovery parameters are entered into the Visual HEA software package and each impact and mitigation activity are analyzed by the software, which calculates the necessary mitigation for the impact. Based on the input parameters, and outputs from Visual HEA for Component 1 and Indirect Impacts associated with construction, the mitigation required for the Port Everglades OEC expansion is the creation of 5 acres of boulder reef, 2.03 acres with transplanted corals and 2.97 without transplanted corals and outplanting of 103,191 corals from nurseries over 18.21 acres of enhancement areas (Table 21); the addition of Component 2 results in a total mitigation requirement for the outplanting of 29,278 corals from nurseries over 10.13 acres, assuming a 100% loss of habitat associated with anchor/cable impacts; the addition of Component 3 results in a total mitigation requirement for the outplanting of 23,105 corals over 7.99 acres. Construction of these mitigation options yields a stream of benefits that would extend for the life of the created boulder reef and enhancement areas. In addition, there would be increased values (service gains) from the natural recovery of the impacted area over some interval of time, even if that area were to be maintenance-dredged in 10, 20, or 30 years following construction of the proposed OEC expansion. Therefore, in sum, the total ecological services rendered by (1) the temporal services provided in the impact area between maintenance events and (2) the creation of a minimum of five acres as well as the outplanting of nursery corals, dependent upon construction methodology and results of during construction monitoring, of new live-bottom habitat and enhanced habitats will provide sufficient compensation for the proposed project. These mitigation options were guided by assumptions based on scientific literature and field observations, and use of conservative natural resource principles in the absence of documentation, as detailed on previous pages.

Table 21 Acres of mitigation required for impact Component 1

Mitigation Requirement	
Category	**Acres**
Component 1 – boulder reef w/transplants	2.03
Component 1 – boulder reef w/o transplants	2.97
Component 1 – outplanting nursery corals	103,191 corals over 18.21 acres of enhancement

Table 22 Acres of contingency mitigation required for impact Component 2

Mitigation Requirement	
Category	**Acres**
Direct Anchor and Cable Impacts	29,278 corals over 10.13 acres of enhancement

Table 23 Acres of contingency mitigation required for impact Component 3

Mitigation Requirement	
Category	**Acres**
Middle and Outer Reef Impacts by Rubble Movement to Remaining 90% of Habitat Below Dredge Depth	23,105 corals over 7.99 acres of enhancement

Table 24 Acres of mitigation required for Indirect Effects

Mitigation Requirement	
Category	**Acres**
In Assoc w/Component 1	6,387 corals over 1.13 acres of enhancement
In Assoc w/Component 1 & 2	3,354 corals over 0.59 acres of enhancement

Table 25 Total Mitigation Requirements

Mitigation Requirement	
Impacts	**Acres**
Component 1 + Indirect	5 acres of boulder reef + 103,191 coral outplants
Components 1 & 2 + Indirect	5 acres of boulder reef + 132,469 coral outplants
Components 1,2,3 + Indirect	5 acres of boulder reef + 155,574 coral outplants
Components 1 & 3 + Indirect	5 acres of boulder reef + 126,296 coral outplants

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APPENDIX A

HEA Input/Output Summaries and Data

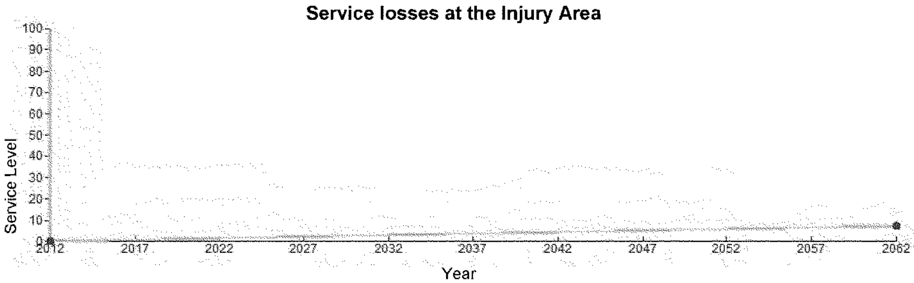
Complete HEA Data are included on the enclosed CD.

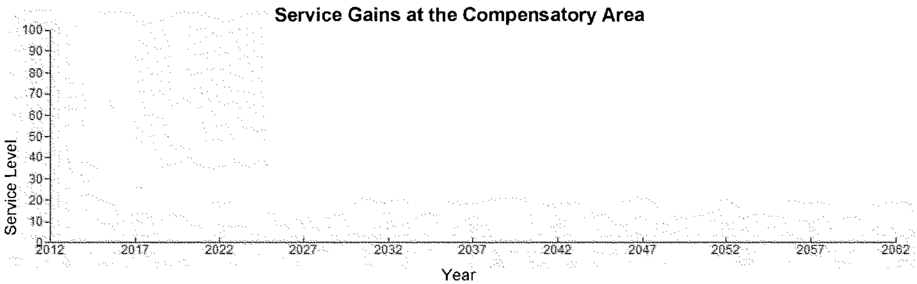
VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

Sitename: Component 1 - 57ft
Run date: 4/17/2014 1:18:46 PM
HEA datafile:
G:\\Port Everglades\\Mitigation\\HEA report\\Mitigation Analysis Report (Modified HEA)\\Final Mitigation Report\\HEA software files\\Component 1 (no direct) 2008 LADS - 57ft.hea

Current year: 2012
Number of area units injured: 15.33
Area units: acre

Discount rate(%): 0.000
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%





Service losses at the Injury Area

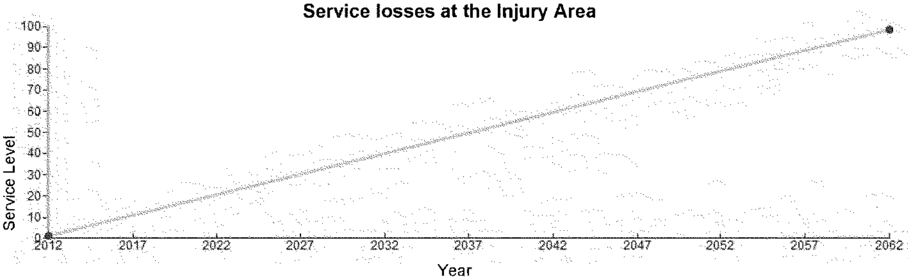
Year	% Services lost					
	Beginning	End	Mean	Raw SAYS lost	Discount Factor	Discounted SAYS lost
2012	100.00%	99.85%	99.92%	15.319	1.000	15.319
2013	99.85%	99.70%	99.77%	15.296	1.000	15.296
2014	99.70%	99.55%	99.62%	15.273	1.000	15.273
2015	99.55%	99.40%	99.47%	15.250	1.000	15.250
2016	99.40%	99.25%	99.32%	15.227	1.000	15.227
2017	99.25%	99.10%	99.17%	15.204	1.000	15.204
2018	99.10%	98.95%	99.02%	15.181	1.000	15.181
2019	98.95%	98.80%	98.87%	15.158	1.000	15.158
2020	98.80%	98.65%	98.72%	15.135	1.000	15.135
2021	98.65%	98.50%	98.57%	15.112	1.000	15.112
2022	98.50%	98.35%	98.42%	15.089	1.000	15.089
2023	98.35%	98.20%	98.27%	15.066	1.000	15.066
2024	98.20%	98.05%	98.12%	15.043	1.000	15.043
2025	98.05%	97.90%	97.97%	15.020	1.000	15.020
2026	97.90%	97.75%	97.82%	14.997	1.000	14.997
2027	97.75%	97.60%	97.67%	14.974	1.000	14.974
2028	97.60%	97.45%	97.52%	14.951	1.000	14.951
2029	97.45%	97.30%	97.37%	14.928	1.000	14.928
2030	97.30%	97.15%	97.22%	14.905	1.000	14.905
2031	97.15%	97.00%	97.07%	14.882	1.000	14.882
2032	97.00%	96.85%	96.92%	14.859	1.000	14.859
2033	96.85%	96.70%	96.77%	14.836	1.000	14.836
2034	96.70%	96.55%	96.62%	14.813	1.000	14.813
2035	96.55%	96.40%	96.47%	14.790	1.000	14.790
2036	96.40%	96.25%	96.32%	14.767	1.000	14.767
2037	96.25%	96.10%	96.17%	14.744	1.000	14.744
2038	96.10%	95.95%	96.02%	14.721	1.000	14.721
2039	95.95%	95.80%	95.87%	14.698	1.000	14.698
2040	95.80%	95.65%	95.72%	14.675	1.000	14.675
2041	95.65%	95.50%	95.57%	14.652	1.000	14.652
2042	95.50%	95.35%	95.42%	14.629	1.000	14.629
2043	95.35%	95.20%	95.27%	14.606	1.000	14.606
2044	95.20%	95.05%	95.12%	14.583	1.000	14.583
2045	95.05%	94.90%	94.97%	14.560	1.000	14.560
2046	94.90%	94.75%	94.82%	14.537	1.000	14.537
2047	94.75%	94.60%	94.67%	14.514	1.000	14.514
2048	94.60%	94.45%	94.52%	14.491	1.000	14.491
2049	94.45%	94.30%	94.37%	14.468	1.000	14.468
2050	94.30%	94.15%	94.22%	14.445	1.000	14.445
2051	94.15%	94.00%	94.07%	14.422	1.000	14.422
2052	94.00%	93.85%	93.92%	14.399	1.000	14.399
2053	93.85%	93.70%	93.77%	14.376	1.000	14.376
2054	93.70%	93.55%	93.62%	14.353	1.000	14.353
2055	93.55%	93.40%	93.47%	14.330	1.000	14.330
2056	93.40%	93.25%	93.32%	14.307	1.000	14.307
2057	93.25%	93.10%	93.17%	14.284	1.000	14.284
2058	93.10%	92.95%	93.02%	14.261	1.000	14.261
2059	92.95%	92.80%	92.87%	14.238	1.000	14.238
2060	92.80%	92.65%	92.72%	14.215	1.000	14.215
2061	92.65%	92.50%	92.57%	14.192	1.000	14.192
2062	92.50%	92.50%	92.50%	14.180	1.000	14.180

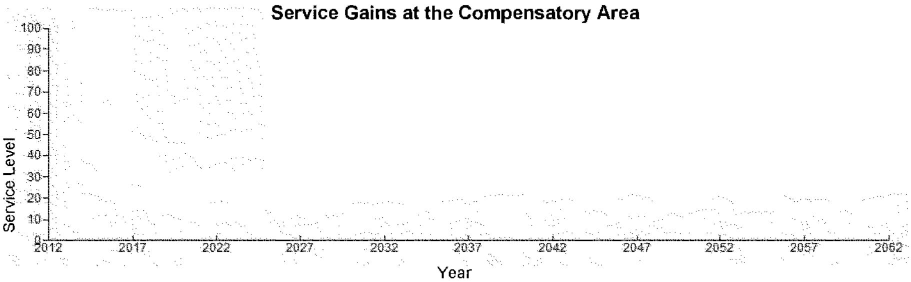
VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

Sitename: Anchor Cable - Comp 2 - 2008 LADS
Run date: 2/25/2014 1:12:21 PM
HEA datafile:
Z:\\Terri_Jordan-Sellers\\Project_Files\\Port Everglades\\Mitigation\\HEA report\\Mitigation Analysis Report (Modified HEA)\\Final Mitigation Report\\HEA software files\\Component 2 - Anch

Current year: 2012
Number of area units injured: 15.04
Area units: acre
Total gain per year per unit: 0.00
Value ratio (lost/restored): 1.00

Discount rate(%): 0.000
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%





Service losses at the Injury Area

Year	% Services lost Beginning	End	Mean	Raw SAYS lost	Discount Factor	Discounted SAYS lost
2012	99.00%	97.06%	98.03%	14.744	1.000	14.744
2013	97.06%	95.12%	96.09%	14.452	1.000	14.452
2014	95.12%	93.18%	94.15%	14.160	1.000	14.160
2015	93.18%	91.24%	92.21%	13.868	1.000	13.868
2016	91.24%	89.30%	90.27%	13.577	1.000	13.577
2017	89.30%	87.36%	88.33%	13.285	1.000	13.285
2018	87.36%	85.42%	86.39%	12.993	1.000	12.993
2019	85.42%	83.48%	84.45%	12.701	1.000	12.701
2020	83.48%	81.54%	82.51%	12.410	1.000	12.410
2021	81.54%	79.60%	80.57%	12.118	1.000	12.118
2022	79.60%	77.66%	78.63%	11.826	1.000	11.826
2023	77.66%	75.72%	76.69%	11.534	1.000	11.534
2024	75.72%	73.78%	74.75%	11.242	1.000	11.242
2025	73.78%	71.84%	72.81%	10.951	1.000	10.951
2026	71.84%	69.90%	70.87%	10.659	1.000	10.659
2027	69.90%	67.96%	68.93%	10.367	1.000	10.367
2028	67.96%	66.02%	66.99%	10.075	1.000	10.075
2029	66.02%	64.08%	65.05%	9.784	1.000	9.784
2030	64.08%	62.14%	63.11%	9.492	1.000	9.492
2031	62.14%	60.20%	61.17%	9.200	1.000	9.200
2032	60.20%	58.26%	59.23%	8.908	1.000	8.908
2033	58.26%	56.32%	57.29%	8.616	1.000	8.616
2034	56.32%	54.38%	55.35%	8.325	1.000	8.325
2035	54.38%	52.44%	53.41%	8.033	1.000	8.033
2036	52.44%	50.50%	51.47%	7.741	1.000	7.741
2037	50.50%	48.56%	49.53%	7.449	1.000	7.449
2038	48.56%	46.62%	47.59%	7.158	1.000	7.158
2039	46.62%	44.68%	45.65%	6.866	1.000	6.866
2040	44.68%	42.74%	43.71%	6.574	1.000	6.574
2041	42.74%	40.80%	41.77%	6.282	1.000	6.282
2042	40.80%	38.86%	39.83%	5.990	1.000	5.990
2043	38.86%	36.92%	37.89%	5.699	1.000	5.699
2044	36.92%	34.98%	35.95%	5.407	1.000	5.407
2045	34.98%	33.04%	34.01%	5.115	1.000	5.115
2046	33.04%	31.10%	32.07%	4.823	1.000	4.823
2047	31.10%	29.16%	30.13%	4.532	1.000	4.532
2048	29.16%	27.22%	28.19%	4.240	1.000	4.240
2049	27.22%	25.28%	26.25%	3.948	1.000	3.948
2050	25.28%	23.34%	24.31%	3.656	1.000	3.656
2051	23.34%	21.40%	22.37%	3.364	1.000	3.364
2052	21.40%	19.46%	20.43%	3.073	1.000	3.073
2053	19.46%	17.52%	18.49%	2.781	1.000	2.781
2054	17.52%	15.58%	16.55%	2.489	1.000	2.489
2055	15.58%	13.64%	14.61%	2.197	1.000	2.197
2056	13.64%	11.70%	12.67%	1.906	1.000	1.906
2057	11.70%	9.76%	10.73%	1.614	1.000	1.614
2058	9.76%	7.82%	8.79%	1.322	1.000	1.322
2059	7.82%	5.88%	6.85%	1.030	1.000	1.030
2060	5.88%	3.94%	4.91%	0.738	1.000	0.738
2061	3.94%	2.00%	2.97%	0.447	1.000	0.447
2062	2.00%	2.00%	2.00%	0.301	1.000	0.301

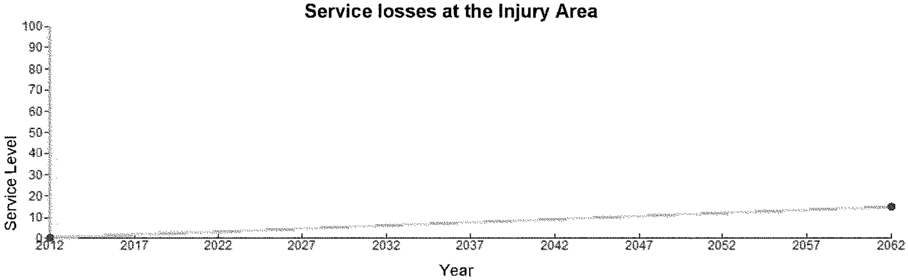
VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

Sitename: Component 3 - Below Dredge Depth - 57 2008 LADS
Run date: 2/25/2014 1:12:49 PM
HEA datafile:
Z:\\Terri_Jordan-Sellers\\Project_Files\\Port Everglades\\Mitigation\\HEA report\\Mitigation Analysis Report (Modified HEA)\\Final Mitigation Report\\HEA software files\\Component 3 - rubbl

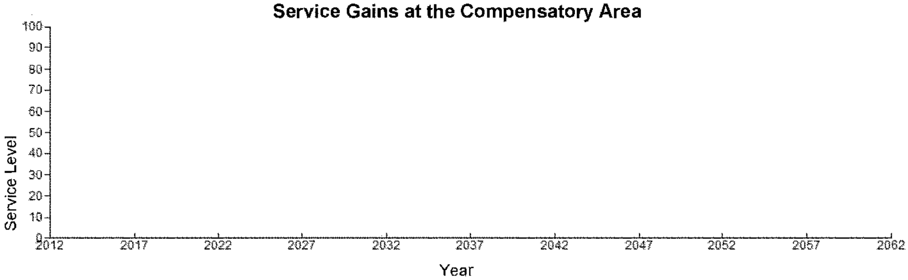
Current year: 2012
Number of area units injured: 6.368
Area units: acre

Discount rate(%): 0.000
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%

Service losses at the Injury Area



Service Gains at the Compensatory Area



Service losses at the Injury Area

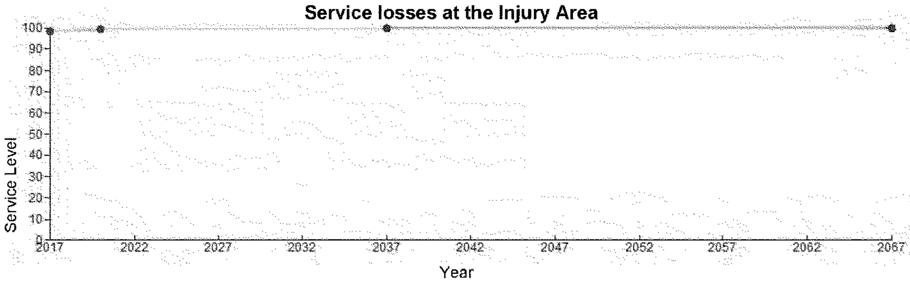
Year	% Services lost Beginning	End	Mean	Raw SAYS lost	Discount Factor	Discounted SAYS lost
2012	100.00%	99.70%	99.85%	6.358	1.000	6.358
2013	99.70%	99.40%	99.55%	6.339	1.000	6.339
2014	99.40%	99.10%	99.25%	6.320	1.000	6.320
2015	99.10%	98.80%	98.95%	6.301	1.000	6.301
2016	98.80%	98.50%	98.65%	6.282	1.000	6.282
2017	98.50%	98.20%	98.35%	6.263	1.000	6.263
2018	98.20%	97.90%	98.05%	6.244	1.000	6.244
2019	97.90%	97.60%	97.75%	6.225	1.000	6.225
2020	97.60%	97.30%	97.45%	6.206	1.000	6.206
2021	97.30%	97.00%	97.15%	6.187	1.000	6.187
2022	97.00%	96.70%	96.85%	6.167	1.000	6.167
2023	96.70%	96.40%	96.55%	6.148	1.000	6.148
2024	96.40%	96.10%	96.25%	6.129	1.000	6.129
2025	96.10%	95.80%	95.95%	6.110	1.000	6.110
2026	95.80%	95.50%	95.65%	6.091	1.000	6.091
2027	95.50%	95.20%	95.35%	6.072	1.000	6.072
2028	95.20%	94.90%	95.05%	6.053	1.000	6.053
2029	94.90%	94.60%	94.75%	6.034	1.000	6.034
2030	94.60%	94.30%	94.45%	6.015	1.000	6.015
2031	94.30%	94.00%	94.15%	5.995	1.000	5.995
2032	94.00%	93.70%	93.85%	5.976	1.000	5.976
2033	93.70%	93.40%	93.55%	5.957	1.000	5.957
2034	93.40%	93.10%	93.25%	5.938	1.000	5.938
2035	93.10%	92.80%	92.95%	5.919	1.000	5.919
2036	92.80%	92.50%	92.65%	5.900	1.000	5.900
2037	92.50%	92.20%	92.35%	5.881	1.000	5.881
2038	92.20%	91.90%	92.05%	5.862	1.000	5.862
2039	91.90%	91.60%	91.75%	5.843	1.000	5.843
2040	91.60%	91.30%	91.45%	5.824	1.000	5.824
2041	91.30%	91.00%	91.15%	5.804	1.000	5.804
2042	91.00%	90.70%	90.85%	5.785	1.000	5.785
2043	90.70%	90.40%	90.55%	5.766	1.000	5.766
2044	90.40%	90.10%	90.25%	5.747	1.000	5.747
2045	90.10%	89.80%	89.95%	5.728	1.000	5.728
2046	89.80%	89.50%	89.65%	5.709	1.000	5.709
2047	89.50%	89.20%	89.35%	5.690	1.000	5.690
2048	89.20%	88.90%	89.05%	5.671	1.000	5.671
2049	88.90%	88.60%	88.75%	5.652	1.000	5.652
2050	88.60%	88.30%	88.45%	5.632	1.000	5.632
2051	88.30%	88.00%	88.15%	5.613	1.000	5.613
2052	88.00%	87.70%	87.85%	5.594	1.000	5.594
2053	87.70%	87.40%	87.55%	5.575	1.000	5.575
2054	87.40%	87.10%	87.25%	5.556	1.000	5.556
2055	87.10%	86.80%	86.95%	5.537	1.000	5.537
2056	86.80%	86.50%	86.65%	5.518	1.000	5.518
2057	86.50%	86.20%	86.35%	5.499	1.000	5.499
2058	86.20%	85.90%	86.05%	5.480	1.000	5.480
2059	85.90%	85.60%	85.75%	5.461	1.000	5.461
2060	85.60%	85.30%	85.45%	5.441	1.000	5.441
2061	85.30%	85.00%	85.15%	5.422	1.000	5.422
2062	85.00%	85.00%	85.00%	5.413	1.000	5.413

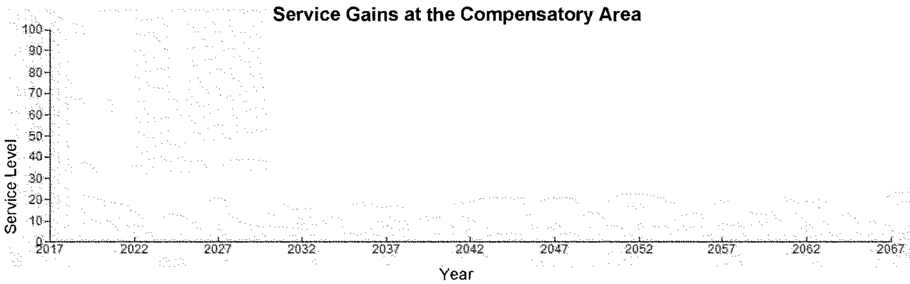
VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

Sitename: Indirect Impacts w Comp 1
Run date: 1/30/2014 3:47:14 PM
HEA datafile:
Z:\\Terri_Jordan-Sellers\\Project_Files\\Port Everglades\\Mitigation\\HEA report\\Mitigation Analysis Report (Modified HEA)\\Final Mitigation Report\\HEA restored files\\Indirect - Comp 1 - 2

Current year: 2017
Number of area units injured: 112.59
Area units: acre

Discount rate(%): 0.000
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%





Service losses at the Injury Area

Year	% Services lost Beginning	End	Mean	Raw SAYS lost	Discount Factor	Discounted SAYS lost
2017	2.00%	1.67%	1.83%	2.064	1.000	2.064
2018	1.67%	1.33%	1.50%	1.689	1.000	1.689
2019	1.33%	1.00%	1.17%	1.314	1.000	1.314
2020	1.00%	.97%	0.99%	1.109	1.000	1.109
2021	.97%	.94%	0.96%	1.076	1.000	1.076
2022	.94%	.91%	0.93%	1.043	1.000	1.043
2023	.91%	.88%	0.90%	1.010	1.000	1.010
2024	.88%	.85%	0.87%	0.977	1.000	0.977
2025	.85%	.82%	0.84%	0.944	1.000	0.944
2026	.82%	.79%	0.81%	0.911	1.000	0.911
2027	.79%	.76%	0.78%	0.878	1.000	0.878
2028	.76%	.74%	0.75%	0.844	1.000	0.844
2029	.74%	.71%	0.72%	0.811	1.000	0.811
2030	.71%	.68%	0.69%	0.778	1.000	0.778
2031	.68%	.65%	0.66%	0.745	1.000	0.745
2032	.65%	.62%	0.63%	0.712	1.000	0.712
2033	.62%	.59%	0.60%	0.679	1.000	0.679
2034	.59%	.56%	0.57%	0.646	1.000	0.646
2035	.56%	.53%	0.54%	0.613	1.000	0.613
2036	.53%	.50%	0.51%	0.580	1.000	0.580
2037	.50%	.48%	0.49%	0.554	1.000	0.554
2038	.48%	.47%	0.47%	0.535	1.000	0.535
2039	.47%	.45%	0.46%	0.516	1.000	0.516
2040	.45%	.43%	0.44%	0.497	1.000	0.497
2041	.43%	.42%	0.42%	0.479	1.000	0.479
2042	.42%	.40%	0.41%	0.460	1.000	0.460
2043	.40%	.38%	0.39%	0.441	1.000	0.441
2044	.38%	.37%	0.37%	0.422	1.000	0.422
2045	.37%	.35%	0.36%	0.403	1.000	0.403
2046	.35%	.33%	0.34%	0.385	1.000	0.385
2047	.33%	.32%	0.32%	0.366	1.000	0.366
2048	.32%	.30%	0.31%	0.347	1.000	0.347
2049	.30%	.28%	0.29%	0.328	1.000	0.328
2050	.28%	.27%	0.27%	0.310	1.000	0.310
2051	.27%	.25%	0.26%	0.291	1.000	0.291
2052	.25%	.23%	0.24%	0.272	1.000	0.272
2053	.23%	.22%	0.22%	0.253	1.000	0.253
2054	.22%	.20%	0.21%	0.235	1.000	0.235
2055	.20%	.18%	0.19%	0.216	1.000	0.216
2056	.18%	.17%	0.17%	0.197	1.000	0.197
2057	.17%	.15%	0.16%	0.178	1.000	0.178
2058	.15%	.13%	0.14%	0.160	1.000	0.160
2059	.13%	.12%	0.12%	0.141	1.000	0.141
2060	.12%	.10%	0.11%	0.122	1.000	0.122
2061	.10%	.08%	0.09%	0.103	1.000	0.103
2062	.08%	.07%	0.07%	0.084	1.000	0.084
2063	.07%	.05%	0.06%	0.066	1.000	0.066
2064	.05%	.03%	0.04%	0.047	1.000	0.047
2065	.03%	.02%	0.02%	0.028	1.000	0.028
2066	.02%	.00%	0.01%	0.009	1.000	0.009
2067	.00%	.00%	0.00%	0.000	1.000	0.000

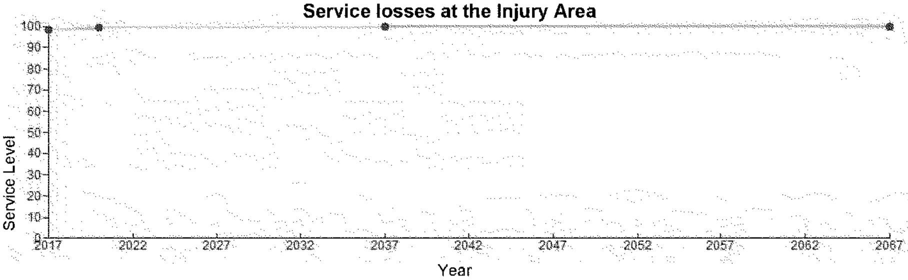
VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

Sitename: Indirect Impacts w Comp 1 & 2
Run date: 2/25/2014 12:54:26 PM
HEA datafile:
Z:\\Terri_Jordan-Sellers\\Project_Files\\Port Everglades\\Mitigation\\HEA report\\Mitigation Analysis Report (Modified HEA)\\Final Mitigation Report\\HEA\\software files\\Indirect - Comp 1 - 2

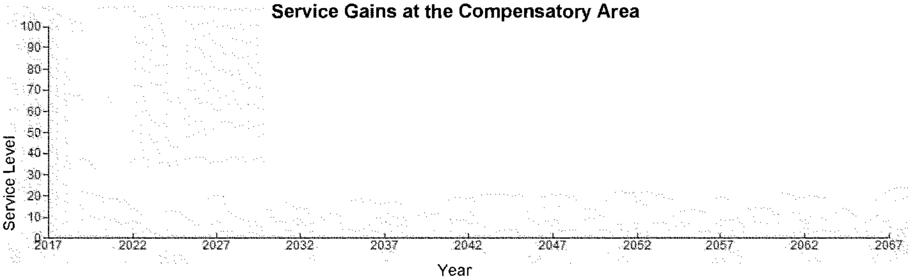
Current year: 2017
Number of area units injured: 89.763
Area units: acre

Discount rate(%): 0.000
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%

Service losses at the Injury Area



Service Gains at the Compensatory Area



Service losses at the Injury Area

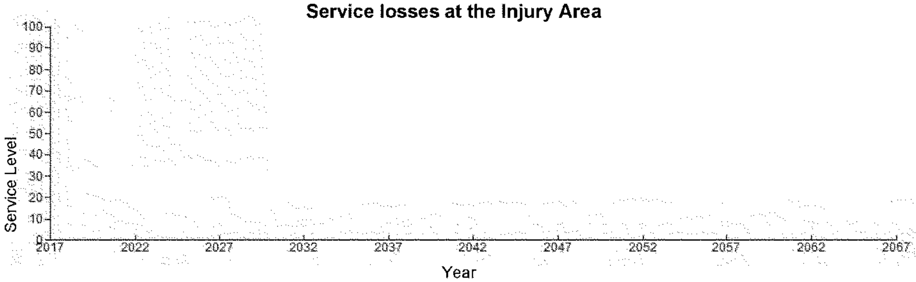
Year	% Services lost					
	Beginning	End	Mean	Raw SAYS lost	Discount Factor	Discounted SAYS lost
2017	2.00%	1.67%	1.83%	1.646	1.000	1.646
2018	1.67%	1.33%	1.50%	1.346	1.000	1.346
2019	1.33%	1.00%	1.17%	1.047	1.000	1.047
2020	1.00%	.97%	0.99%	0.884	1.000	0.884
2021	.97%	.94%	0.96%	0.858	1.000	0.858
2022	.94%	.91%	0.93%	0.832	1.000	0.832
2023	.91%	.88%	0.90%	0.805	1.000	0.805
2024	.88%	.85%	0.87%	0.779	1.000	0.779
2025	.85%	.82%	0.84%	0.752	1.000	0.752
2026	.82%	.79%	0.81%	0.726	1.000	0.726
2027	.79%	.76%	0.78%	0.700	1.000	0.700
2028	.76%	.74%	0.75%	0.673	1.000	0.673
2029	.74%	.71%	0.72%	0.647	1.000	0.647
2030	.71%	.68%	0.69%	0.620	1.000	0.620
2031	.68%	.65%	0.66%	0.594	1.000	0.594
2032	.65%	.62%	0.63%	0.568	1.000	0.568
2033	.62%	.59%	0.60%	0.541	1.000	0.541
2034	.59%	.56%	0.57%	0.515	1.000	0.515
2035	.56%	.53%	0.54%	0.488	1.000	0.488
2036	.53%	.50%	0.51%	0.462	1.000	0.462
2037	.50%	.48%	0.49%	0.441	1.000	0.441
2038	.48%	.47%	0.47%	0.426	1.000	0.426
2039	.47%	.45%	0.46%	0.411	1.000	0.411
2040	.45%	.43%	0.44%	0.396	1.000	0.396
2041	.43%	.42%	0.42%	0.381	1.000	0.381
2042	.42%	.40%	0.41%	0.367	1.000	0.367
2043	.40%	.38%	0.39%	0.352	1.000	0.352
2044	.38%	.37%	0.37%	0.337	1.000	0.337
2045	.37%	.35%	0.36%	0.322	1.000	0.322
2046	.35%	.33%	0.34%	0.307	1.000	0.307
2047	.33%	.32%	0.32%	0.292	1.000	0.292
2048	.32%	.30%	0.31%	0.277	1.000	0.277
2049	.30%	.28%	0.29%	0.262	1.000	0.262
2050	.28%	.27%	0.27%	0.247	1.000	0.247
2051	.27%	.25%	0.26%	0.232	1.000	0.232
2052	.25%	.23%	0.24%	0.217	1.000	0.217
2053	.23%	.22%	0.22%	0.202	1.000	0.202
2054	.22%	.20%	0.21%	0.187	1.000	0.187
2055	.20%	.18%	0.19%	0.172	1.000	0.172
2056	.18%	.17%	0.17%	0.157	1.000	0.157
2057	.17%	.15%	0.16%	0.142	1.000	0.142
2058	.15%	.13%	0.14%	0.127	1.000	0.127
2059	.13%	.12%	0.12%	0.112	1.000	0.112
2060	.12%	.10%	0.11%	0.097	1.000	0.097
2061	.10%	.08%	0.09%	0.082	1.000	0.082
2062	.08%	.07%	0.07%	0.067	1.000	0.067
2063	.07%	.05%	0.06%	0.052	1.000	0.052
2064	.05%	.03%	0.04%	0.037	1.000	0.037
2065	.03%	.02%	0.02%	0.022	1.000	0.022
2066	.02%	.00%	0.01%	0.007	1.000	0.007
2067	.00%	.00%	0.00%	0.000	1.000	0.000

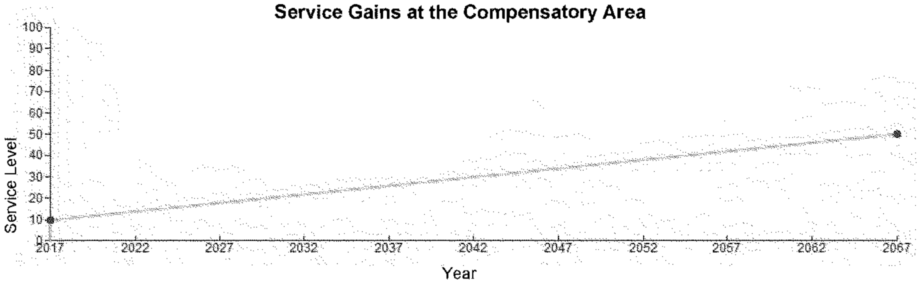
VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

Sitename: Boulers only
Run date: 2/25/2014 1:16:11 PM
HEA datafile:
Z:\\Terri_Jordan-Sellers\\Project_Files\\Port Everglades\\Mitigation\\HEA report\\Mitigation Analysis Report (Modified HEA)\\Final Mitigation Report (jhe)\\HEA software files\\Boulders_Only.hea

Current year: 2017
Number of area units injured: 1
Area units: acre

Discount rate(%): 0.000
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%





Service Gains at the Compensatory Area

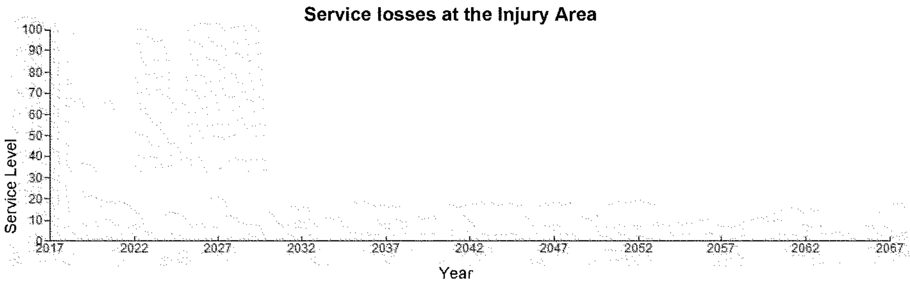
Year	% Services gained					
	Beginning	End	Mean	Raw SAYS lost	Discount Factor	Discounted SAYS gained
2017	10.00%	10.80%	10.40%	0.104	1.000	0.104
2018	10.80%	11.60%	11.20%	0.112	1.000	0.112
2019	11.60%	12.40%	12.00%	0.120	1.000	0.120
2020	12.40%	13.20%	12.80%	0.128	1.000	0.128
2021	13.20%	14.00%	13.60%	0.136	1.000	0.136
2022	14.00%	14.80%	14.40%	0.144	1.000	0.144
2023	14.80%	15.60%	15.20%	0.152	1.000	0.152
2024	15.60%	16.40%	16.00%	0.160	1.000	0.160
2025	16.40%	17.20%	16.80%	0.168	1.000	0.168
2026	17.20%	18.00%	17.60%	0.176	1.000	0.176
2027	18.00%	18.80%	18.40%	0.184	1.000	0.184
2028	18.80%	19.60%	19.20%	0.192	1.000	0.192
2029	19.60%	20.40%	20.00%	0.200	1.000	0.200
2030	20.40%	21.20%	20.80%	0.208	1.000	0.208
2031	21.20%	22.00%	21.60%	0.216	1.000	0.216
2032	22.00%	22.80%	22.40%	0.224	1.000	0.224
2033	22.80%	23.60%	23.20%	0.232	1.000	0.232
2034	23.60%	24.40%	24.00%	0.240	1.000	0.240
2035	24.40%	25.20%	24.80%	0.248	1.000	0.248
2036	25.20%	26.00%	25.60%	0.256	1.000	0.256
2037	26.00%	26.80%	26.40%	0.264	1.000	0.264
2038	26.80%	27.60%	27.20%	0.272	1.000	0.272
2039	27.60%	28.40%	28.00%	0.280	1.000	0.280
2040	28.40%	29.20%	28.80%	0.288	1.000	0.288
2041	29.20%	30.00%	29.60%	0.296	1.000	0.296
2042	30.00%	30.80%	30.40%	0.304	1.000	0.304
2043	30.80%	31.60%	31.20%	0.312	1.000	0.312
2044	31.60%	32.40%	32.00%	0.320	1.000	0.320
2045	32.40%	33.20%	32.80%	0.328	1.000	0.328
2046	33.20%	34.00%	33.60%	0.336	1.000	0.336
2047	34.00%	34.80%	34.40%	0.344	1.000	0.344
2048	34.80%	35.60%	35.20%	0.352	1.000	0.352
2049	35.60%	36.40%	36.00%	0.360	1.000	0.360
2050	36.40%	37.20%	36.80%	0.368	1.000	0.368
2051	37.20%	38.00%	37.60%	0.376	1.000	0.376
2052	38.00%	38.80%	38.40%	0.384	1.000	0.384
2053	38.80%	39.60%	39.20%	0.392	1.000	0.392
2054	39.60%	40.40%	40.00%	0.400	1.000	0.400
2055	40.40%	41.20%	40.80%	0.408	1.000	0.408
2056	41.20%	42.00%	41.60%	0.416	1.000	0.416
2057	42.00%	42.80%	42.40%	0.424	1.000	0.424
2058	42.80%	43.60%	43.20%	0.432	1.000	0.432
2059	43.60%	44.40%	44.00%	0.440	1.000	0.440
2060	44.40%	45.20%	44.80%	0.448	1.000	0.448
2061	45.20%	46.00%	45.60%	0.456	1.000	0.456
2062	46.00%	46.80%	46.40%	0.464	1.000	0.464
2063	46.80%	47.60%	47.20%	0.472	1.000	0.472
2064	47.60%	48.40%	48.00%	0.480	1.000	0.480
2065	48.40%	49.20%	48.80%	0.488	1.000	0.488
2066	49.20%	50.00%	49.60%	0.496	1.000	0.496
2067	50.00%	50.00%	50.00%	0.500	1.000	0.500

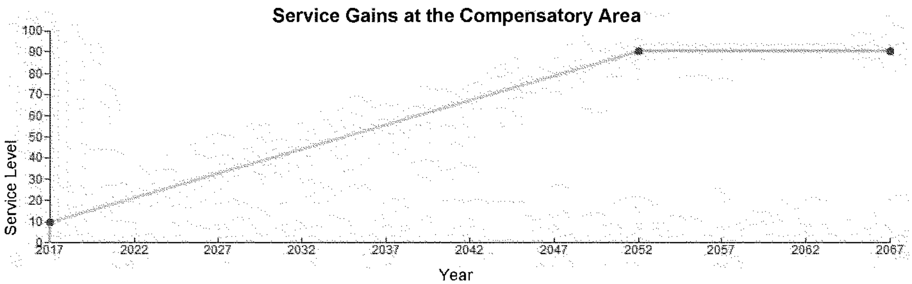
VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

Sitename: Boulers w/transplants
Run date: 2/25/2014 1:16:34 PM
HEA datafile:
Z:\\Terri_Jordan-Sellers\\Project_Files\\Port Everglades\\Mitigation\\HEA report\\Mitigation Analysis Report (Modified HEA)\\Final Mitigation Report\\HEA software files\\BouldersWtransplant

Current year: 2017
Number of area units injured: 1
Area units: acre

Discount rate(%): 0.000
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%





Service Gains at the Compensatory Area

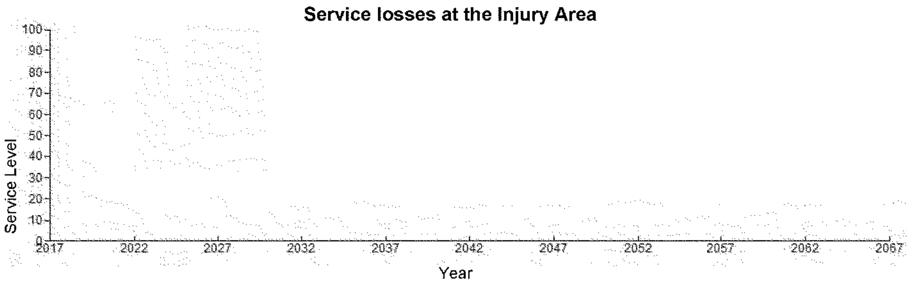
Year	% Services gained					
	Beginning	End	Mean	Raw SAYS lost	Discount Factor	Discounted SAYS gained
2017	10.00%	12.29%	11.14%	0.111	1.000	0.111
2018	12.29%	14.57%	13.43%	0.134	1.000	0.134
2019	14.57%	16.86%	15.71%	0.157	1.000	0.157
2020	16.86%	19.14%	18.00%	0.180	1.000	0.180
2021	19.14%	21.43%	20.29%	0.203	1.000	0.203
2022	21.43%	23.71%	22.57%	0.226	1.000	0.226
2023	23.71%	26.00%	24.86%	0.249	1.000	0.249
2024	26.00%	28.29%	27.14%	0.271	1.000	0.271
2025	28.29%	30.57%	29.43%	0.294	1.000	0.294
2026	30.57%	32.86%	31.71%	0.317	1.000	0.317
2027	32.86%	35.14%	34.00%	0.340	1.000	0.340
2028	35.14%	37.43%	36.29%	0.363	1.000	0.363
2029	37.43%	39.71%	38.57%	0.386	1.000	0.386
2030	39.71%	42.00%	40.86%	0.409	1.000	0.409
2031	42.00%	44.29%	43.14%	0.431	1.000	0.431
2032	44.29%	46.57%	45.43%	0.454	1.000	0.454
2033	46.57%	48.86%	47.71%	0.477	1.000	0.477
2034	48.86%	51.14%	50.00%	0.500	1.000	0.500
2035	51.14%	53.43%	52.29%	0.523	1.000	0.523
2036	53.43%	55.71%	54.57%	0.546	1.000	0.546
2037	55.71%	58.00%	56.86%	0.569	1.000	0.569
2038	58.00%	60.29%	59.14%	0.591	1.000	0.591
2039	60.29%	62.57%	61.43%	0.614	1.000	0.614
2040	62.57%	64.86%	63.71%	0.637	1.000	0.637
2041	64.86%	67.14%	66.00%	0.660	1.000	0.660
2042	67.14%	69.43%	68.29%	0.683	1.000	0.683
2043	69.43%	71.71%	70.57%	0.706	1.000	0.706
2044	71.71%	74.00%	72.86%	0.729	1.000	0.729
2045	74.00%	76.29%	75.14%	0.751	1.000	0.751
2046	76.29%	78.57%	77.43%	0.774	1.000	0.774
2047	78.57%	80.86%	79.71%	0.797	1.000	0.797
2048	80.86%	83.14%	82.00%	0.820	1.000	0.820
2049	83.14%	85.43%	84.29%	0.843	1.000	0.843
2050	85.43%	87.71%	86.57%	0.866	1.000	0.866
2051	87.71%	90.00%	88.86%	0.889	1.000	0.889
2052	90.00%	90.00%	90.00%	0.900	1.000	0.900
2053	90.00%	90.00%	90.00%	0.900	1.000	0.900
2054	90.00%	90.00%	90.00%	0.900	1.000	0.900
2055	90.00%	90.00%	90.00%	0.900	1.000	0.900
2056	90.00%	90.00%	90.00%	0.900	1.000	0.900
2057	90.00%	90.00%	90.00%	0.900	1.000	0.900
2058	90.00%	90.00%	90.00%	0.900	1.000	0.900
2059	90.00%	90.00%	90.00%	0.900	1.000	0.900
2060	90.00%	90.00%	90.00%	0.900	1.000	0.900
2061	90.00%	90.00%	90.00%	0.900	1.000	0.900
2062	90.00%	90.00%	90.00%	0.900	1.000	0.900
2063	90.00%	90.00%	90.00%	0.900	1.000	0.900
2064	90.00%	90.00%	90.00%	0.900	1.000	0.900
2065	90.00%	90.00%	90.00%	0.900	1.000	0.900
2066	90.00%	90.00%	90.00%	0.900	1.000	0.900
2067	90.00%	90.00%	90.00%	0.900	1.000	0.900

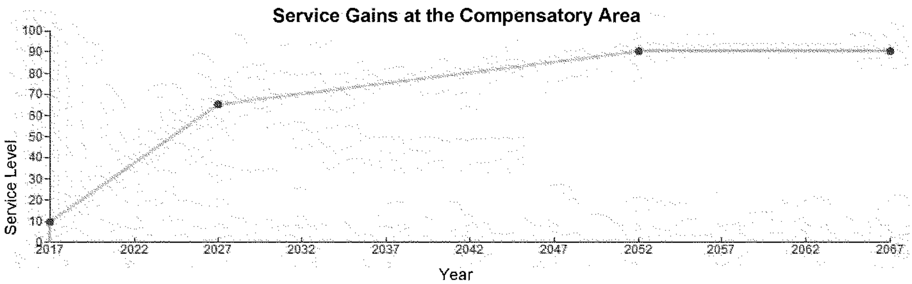
VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

Sitename: EnhancementWoutplants
Run date: 2/25/2014 1:16:58 PM
HEA datafile:
Z:\\Terri_Jordan-Sellers\\Project_Files\\Port Everglades\\Mitigation\\HEA report\\Mitigation Analysis Report (Modified HEA)\\Final Mitigation Report\\HEA software\\files\\EnhancementWtrans

Current year: 2017
Number of area units injured: 1
Area units: acre

Discount rate(%): 0.000
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%





Service Gains at the Compensatory Area

Year	% Services gained					
	Beginning	End	Mean	Raw SAYS lost	Discount Factor	Discounted SAYS gained
2017	10.00%	15.50%	12.75%	0.128	1.000	0.128
2018	15.50%	21.00%	18.25%	0.182	1.000	0.182
2019	21.00%	26.50%	23.75%	0.237	1.000	0.237
2020	26.50%	32.00%	29.25%	0.292	1.000	0.292
2021	32.00%	37.50%	34.75%	0.347	1.000	0.347
2022	37.50%	43.00%	40.25%	0.402	1.000	0.402
2023	43.00%	48.50%	45.75%	0.457	1.000	0.457
2024	48.50%	54.00%	51.25%	0.512	1.000	0.512
2025	54.00%	59.50%	56.75%	0.567	1.000	0.567
2026	59.50%	65.00%	62.25%	0.622	1.000	0.622
2027	65.00%	66.00%	65.50%	0.655	1.000	0.655
2028	66.00%	67.00%	66.50%	0.665	1.000	0.665
2029	67.00%	68.00%	67.50%	0.675	1.000	0.675
2030	68.00%	69.00%	68.50%	0.685	1.000	0.685
2031	69.00%	70.00%	69.50%	0.695	1.000	0.695
2032	70.00%	71.00%	70.50%	0.705	1.000	0.705
2033	71.00%	72.00%	71.50%	0.715	1.000	0.715
2034	72.00%	73.00%	72.50%	0.725	1.000	0.725
2035	73.00%	74.00%	73.50%	0.735	1.000	0.735
2036	74.00%	75.00%	74.50%	0.745	1.000	0.745
2037	75.00%	76.00%	75.50%	0.755	1.000	0.755
2038	76.00%	77.00%	76.50%	0.765	1.000	0.765
2039	77.00%	78.00%	77.50%	0.775	1.000	0.775
2040	78.00%	79.00%	78.50%	0.785	1.000	0.785
2041	79.00%	80.00%	79.50%	0.795	1.000	0.795
2042	80.00%	81.00%	80.50%	0.805	1.000	0.805
2043	81.00%	82.00%	81.50%	0.815	1.000	0.815
2044	82.00%	83.00%	82.50%	0.825	1.000	0.825
2045	83.00%	84.00%	83.50%	0.835	1.000	0.835
2046	84.00%	85.00%	84.50%	0.845	1.000	0.845
2047	85.00%	86.00%	85.50%	0.855	1.000	0.855
2048	86.00%	87.00%	86.50%	0.865	1.000	0.865
2049	87.00%	88.00%	87.50%	0.875	1.000	0.875
2050	88.00%	89.00%	88.50%	0.885	1.000	0.885
2051	89.00%	90.00%	89.50%	0.895	1.000	0.895
2052	90.00%	90.00%	90.00%	0.900	1.000	0.900
2053	90.00%	90.00%	90.00%	0.900	1.000	0.900
2054	90.00%	90.00%	90.00%	0.900	1.000	0.900
2055	90.00%	90.00%	90.00%	0.900	1.000	0.900
2056	90.00%	90.00%	90.00%	0.900	1.000	0.900
2057	90.00%	90.00%	90.00%	0.900	1.000	0.900
2058	90.00%	90.00%	90.00%	0.900	1.000	0.900
2059	90.00%	90.00%	90.00%	0.900	1.000	0.900
2060	90.00%	90.00%	90.00%	0.900	1.000	0.900
2061	90.00%	90.00%	90.00%	0.900	1.000	0.900
2062	90.00%	90.00%	90.00%	0.900	1.000	0.900
2063	90.00%	90.00%	90.00%	0.900	1.000	0.900
2064	90.00%	90.00%	90.00%	0.900	1.000	0.900
2065	90.00%	90.00%	90.00%	0.900	1.000	0.900
2066	90.00%	90.00%	90.00%	0.900	1.000	0.900
2067	90.00%	90.00%	90.00%	0.900	1.000	0.900

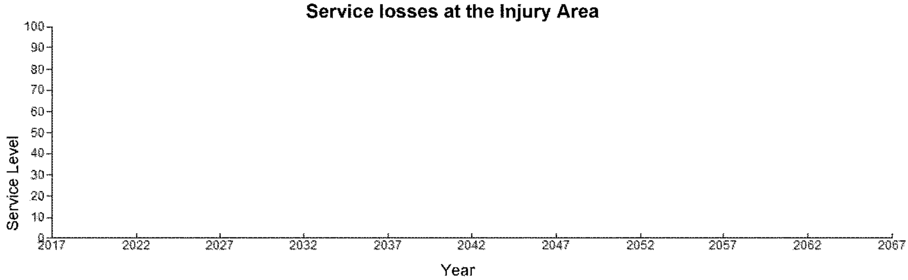
VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

Sitename: EnhancementWoutplants
Run date: 2/25/2014 1:16:58 PM
HEA datafile:
Z:\\Terri_Jordan-Sellers\\Project_Files\\Port Everglades\\Mitigation\\HEA reporTMatigationyAnalysis Report (Modified HEA)\\Final MitigValue Report(injHEA/restored) file80EnhancementWrans

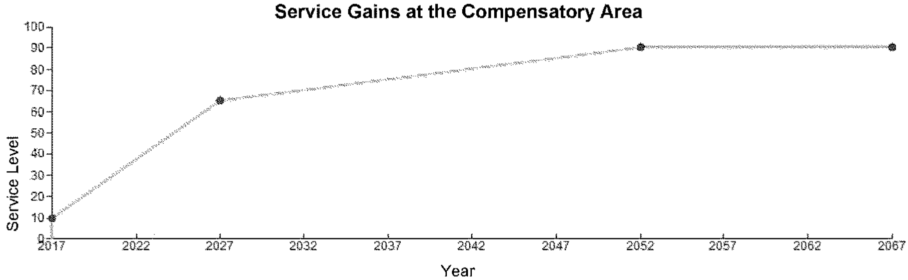
Current year: 2017
Number of area units injured: 1
Area units: acre

Discount rate(%): 0.000
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%

Service losses at the Injury Area



Service Gains at the Compensatory Area



Service Gains at the Compensatory Area

Year	% Services gained					
	Beginning	End	Mean	Raw SAYS lost	Discount Factor	Discounted SAYS gained
2017	10.00%	15.50%	12.75%	0.128	1.000	0.128
2018	15.50%	21.00%	18.25%	0.182	1.000	0.182
2019	21.00%	26.50%	23.75%	0.237	1.000	0.237
2020	26.50%	32.00%	29.25%	0.292	1.000	0.292
2021	32.00%	37.50%	34.75%	0.347	1.000	0.347
2022	37.50%	43.00%	40.25%	0.402	1.000	0.402
2023	43.00%	48.50%	45.75%	0.457	1.000	0.457
2024	48.50%	54.00%	51.25%	0.512	1.000	0.512
2025	54.00%	59.50%	56.75%	0.567	1.000	0.567
2026	59.50%	65.00%	62.25%	0.622	1.000	0.622
2027	65.00%	66.00%	65.50%	0.655	1.000	0.655
2028	66.00%	67.00%	66.50%	0.665	1.000	0.665
2029	67.00%	68.00%	67.50%	0.675	1.000	0.675
2030	68.00%	69.00%	68.50%	0.685	1.000	0.685
2031	69.00%	70.00%	69.50%	0.695	1.000	0.695
2032	70.00%	71.00%	70.50%	0.705	1.000	0.705
2033	71.00%	72.00%	71.50%	0.715	1.000	0.715
2034	72.00%	73.00%	72.50%	0.725	1.000	0.725
2035	73.00%	74.00%	73.50%	0.735	1.000	0.735
2036	74.00%	75.00%	74.50%	0.745	1.000	0.745
2037	75.00%	76.00%	75.50%	0.755	1.000	0.755
2038	76.00%	77.00%	76.50%	0.765	1.000	0.765
2039	77.00%	78.00%	77.50%	0.775	1.000	0.775
2040	78.00%	79.00%	78.50%	0.785	1.000	0.785
2041	79.00%	80.00%	79.50%	0.795	1.000	0.795
2042	80.00%	81.00%	80.50%	0.805	1.000	0.805
2043	81.00%	82.00%	81.50%	0.815	1.000	0.815
2044	82.00%	83.00%	82.50%	0.825	1.000	0.825
2045	83.00%	84.00%	83.50%	0.835	1.000	0.835
2046	84.00%	85.00%	84.50%	0.845	1.000	0.845
2047	85.00%	86.00%	85.50%	0.855	1.000	0.855
2048	86.00%	87.00%	86.50%	0.865	1.000	0.865
2049	87.00%	88.00%	87.50%	0.875	1.000	0.875
2050	88.00%	89.00%	88.50%	0.885	1.000	0.885
2051	89.00%	90.00%	89.50%	0.895	1.000	0.895
2052	90.00%	90.00%	90.00%	0.900	1.000	0.900
2053	90.00%	90.00%	90.00%	0.900	1.000	0.900
2054	90.00%	90.00%	90.00%	0.900	1.000	0.900
2055	90.00%	90.00%	90.00%	0.900	1.000	0.900
2056	90.00%	90.00%	90.00%	0.900	1.000	0.900
2057	90.00%	90.00%	90.00%	0.900	1.000	0.900
2058	90.00%	90.00%	90.00%	0.900	1.000	0.900
2059	90.00%	90.00%	90.00%	0.900	1.000	0.900
2060	90.00%	90.00%	90.00%	0.900	1.000	0.900
2061	90.00%	90.00%	90.00%	0.900	1.000	0.900
2062	90.00%	90.00%	90.00%	0.900	1.000	0.900
2063	90.00%	90.00%	90.00%	0.900	1.000	0.900
2064	90.00%	90.00%	90.00%	0.900	1.000	0.900
2065	90.00%	90.00%	90.00%	0.900	1.000	0.900
2066	90.00%	90.00%	90.00%	0.900	1.000	0.900
2067	90.00%	90.00%	90.00%	0.900	1.000	0.900

APPENDIX B

Multi-Agency HEA Working Group Meetings
Final Reports
September and November 2007.

September 25 & 26, 2007
Port Everglades HEA Meeting Summary Report

Project Overview

Meeting Highlights

Opening

Phil Allen, the Port Director, welcomed everyone and expressed the Port's commitment to sustainability. He emphasized the importance of this group and the need to better to understand environmental and economic impacts. As this project moves forward to the challenge will be to achieve the economic projections for the region and to minimize the impact on the environment. The Port Everglades Board has held workshops with stakeholders and the community on how to meet petroleum, cargo and passenger needs over the next 20 years. The projections depend on this dredging project.

Tom Taylor, the facilitator presented the proposed meeting agenda and guidelines (Appendices A and B). The group agreed that there is a need to seek consensus where possible, to clarify the options where there is not agreement and identify research to be considered. All of this input will be used by the USACE in developing the next project documents. All agencies will have additional opportunities to review and provide comments on in future stages of the project.

On the second day, Glenn Wiltshire, the Deputy Port Director addressed the meeting participants and expressed his appreciation for the progress being made and emphasized the importance of this project.

HEA Overview

Bill Precht, a USACE contractor sought to clarify the science and assumptions behind the draft HEA. His presentation addressed:

1. The benthic community/relic reef system of Broward County.
2. Reef study for EIS prepared by Dial Cordy for corps.
3. Using that info - compare to other Broward county and SE FL studies.
4. Development of HEA input parameters for corps study.
5. HEA mitigation needs - boulders, etc.
6. Locations of possible mitigation sites.

Meeting Objectives Clarification

Terri Jordan, USACE, presented the following information on the HEA approval and appeal processes. The group discussed the importance of reaching consensus on as much as possible in this meeting and identified other points where agencies will have opportunities for input.

Map and Table Selection

The group compared the NCRI and USACE maps (See Appendices C and D) and acknowledged that the areas were the same but that some of the titles are different and agreed to use the NCRI map and titles. They also agreed to discuss the outer, middle and inner reef areas for direct impacts and then the same order for the indirect impacts.

Impact Areas

DIRECT TYPE	MODIFIER1
Outer Reef	**Aggregated Patch Reef
	Spur and Groove
	Linear Reef-Outer
	Colonized Pavement-Deep
Middle Reef	Linear Reef-Middle
Inlet Channel Floor	Inlet Channel Floor
Sand	Sand

IN-DIRECT TYPE	MODIFIER1
Outer Reef	Ridge-Deep
	**Aggregated Patch Reef
	Spur and Groove
	Linear Reef-Outer
	Colonized Pavement-Deep
Middle Reef	Linear Reef-Middle
Inner Reef	Linear Reef-Inner
Near shore HB	Colonized Pavement-Shallow
	Ridge-Shallow
Rubble Shoal	Rubble Shoal
Submerged Breakwater	Submerged Breakwater
Inlet Channel Wall	Inlet Channel Wall
Sand	Sand

Input Parameters

The NCRI HEA parameters were presented and the meeting participants suggested additional parameters and reorganized them to create the following list in two categories: injury and compensatory action parameters. These were then used to evaluate each of the categories of polygons.

INJURY		**COMPENSATORY ACTION**	
1. Claim year= Date of Injury		13. Date of compensatory action	
2. Site name			
3. Type of injury (direct, indirect+)		14. Type of compensatory action	
4. # of injured area units			
5. Pre-injury service level =100%		15. Pre-restoration service level (%)	
6. Degree of service lost of resources immediately following injury (%)		16. Service level of CA upon initial installation	
7. Value-injured/value restored=1			
8. Equilibrium level to which recovery can reach		17. Equilibrium level of service From CA expected	
9. Injury recovery time to equilibrium		18. Time for services to develop from installation to equilibrium	
10. Shape of recovery trajectory=linear		19. Shape of trajectory to equilibrium services	
11. Time units=years		20. Time units=years	

Day One Closing

Summary of activities and results
Refine the Day 2 agenda
Agree on assignments as appropriate

September 26 Opening

Opening comments, Glenn Wiltshire, Deputy Port Director
Share insights from overnight
Revise agenda if needed

Continued Discussion and Consensus Seeking

1300-1400 **HEA Spreadsheet Discussion**
Consider models/spreadsheets to be used by USACE and others
Discuss the process for validating models/spreadsheets
Seek consensus on agency procedures and coordination
Identify next steps for still unresolved issues/assumptions

1400-1430 **Mitigation Options**
Identify options for out-of-kind and in-kind mitigation and the related costs
Solicit suggestions for preparing mitigation proposals

1430-1500 **Other issues**
Margin of error – mitigation and funding for unintended impacts

Day Two Closing

Summary of meeting activities, results and next steps
Concluding comments by participants
Meeting evaluation

Consensus Seeking on Parameter Values for Project Areas

The group discussed the parameter values for the outer, middle and inner reef areas for direct impacts and then the three reef areas for the indirect impacts. The table below shows values agreed to in "normal" font. Where there wasn't agreement, options were identified are shown in "*italics*." Comments on items are included after the table and are referenced by number. Where there was more than one option, each of the agencies rated the acceptability of each option using this scale: 3 = good, 2 = concerned but can live with it or 2 = opposed.

Outer Reef Direct Impacts

INJURY		**COMPENSATORY ACTION**	
1. Claim year = Date of Injury	2012	13. Date of compensatory action	2012
2. Site name	Outer reef		
3. Type of injury (direct, indirect+)	Direct	14. Type of compensatory action	Calculate boulders and have suite of options
4. # of injured area units	13.54 A		
5. Pre-injury service level =100%	100%	15. Pre-restoration service level (%)	Close to 0%
6. Degree of service lost of resources immediately following injury (%)	100%	16. Service level of compensatory action upon initial installation (<u>of designed boulder placement)</u>	0-5%
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	*0, 5 &15%*	17. Equilibrium level of service from CA expected (for boulders with specified transplants)	75,100%
9. Injury recovery time to equilibrium	*50 for 5-15 0 for 0*	18. Time for services to develop from installation to equilibrium	65, 55, 50
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit (%)	*3or6%,*	21. Discount rate	*3-6%*

6 - Degree of service lost of resources immediately following injury (%)

- We could look at key species such as corals or algae.
- We don't want to talk about water quality.
- We should use coral and consider the loss 100%.
- There is a question of whether it has some habitat value.

8 - Equilibrium level to which recovery can reach

- Is the baseline the historic level, the current level or some other level?
- We looked at the recovery on the second reef in 26 years and it is about 5% now and may reach 15% in 50 years.
- It will provide some services immediately.
- The middle reef is not comparable to the third reef.
- Consider a 3 dimensional framework.
- Do a complexity voracity ratio.
- Topography complexity is a factor.
- We lack data; the fall back is "professional judgment."
- Functionality could be all mobile and immobile organisms, not just coral.
- Look at areas where outfall pipes were installed, there are not resources there.

There was not agreement on a value. The following are the agency acceptability ratings for 15, 5 and 0% recovery.

15%

	3	2	1
ACE	X		
FWC			X
B Co EPD			X
FWS			X
EPA			X
NOAA			X
DEP			X
NOVA			X

5%

	3	2	1
ACE			X
FWC		X	
Co EPD		X	
FWS		X	
EPA		X	
NOAA		X	
DEP			X
NOVA		X	

0%

	3	2	1
ACE			X
FWC		X	
Co EPD	X		
FWS	X		
EPA	X		
NOAA		X	
DEP	X		
NOVA		X	

Comments After the Acceptability Rating

- 15 seems good because Bill and others looked at recovery on reef 2 after 26 years and considered 3 in 50 years. Why not?
- We heard Ken's experience with the outfall pipes. It is a very low level of recovery.
- It is not reef like recovery. Should not be a type for type recovery. It is a sand rubble habitat. It is a different coral than in the middle reef.
- I have taken palmetto from the wall
- We can extrapolate but we don't know what was really there.
- We are only looking at the bottom not the sides.
- Bill said 7% now and 15% at 50 years. We don't know if it is at equilibrium now.
- Most of the corals are rooting species and we will have more recruits over time. Equilibrium may not happen for 100 years.
- It may have been buried and re-exposed several times over the 25 years. It is just an assumption.
- The brooding assumes that this will continue.
- Focus on what is meant by services. Bill doesn't mean that there will be a similar coral reef. There may be different services. The functions or services are not defined.
- We can conjure up envelops of reasonableness with in the range of 5-15%. We are not sure where we are. We can do histograms that would help us understand. It bothers us to say, "We can live with it." The closer we get to 0 the less significant it is. NOAA gave a 2.
- We don't know what will happen in the future. From the Keys it will be closer to 0 than 15 %. The area that was dredged in Key West is a wasteland and is stirred up regularly.
- 15% and others are professional judgments. We need a study.
- You could look at Miami harbor impacts on the 3rd reef.
- We may want to do a sensitivity study.
- We could review videos of the Miami Harbor.
- We are talking function and how to get to that function and peoples different experiences.

9. Injury recovery time to equilibrium

- This will depend on whether we decide to use 0, 5 or 15% recovery level. It may be 15% for 50 years. Does it matter for 0-5%?

- Bill used 35 years. 95-97% of corals were in a type/size of 20-25 cm. It took 35 years to achieve the size and density. 50 years was conservative. The difference between 35 to 50 is not that much.
- Past HEA's are set at 35 years because of what one attorney did in one case and it has been sited ever since. We have better information now.
- The oldest corals are about 100 years old. We should use that timeframe.
- Dr. Dodge's PowerPoint showed coral age in Broward County.
- On-site all corals on the third reef were less than 40 cm (with a conservative growth rate).
- There was an inadequate sample size. Dodge's sample was larger.
- There is a possibility that there were larger corals and they were not found.
- Could we combine databases?
- Dave's studies are valuable.
- Our sample size of the third reef may be similar to the countywide sample from the third reef.
- There are colonies that are 4-500 years old but not in the project area. We have to use the data we have been dealt.
- I ran the numbers for 5% for 100 years and 15% for 50 years and there is only a 6% difference in the results. We need to put this parameter into perspective.
- The maximum clearance of 46. Consider prop wash. This area is different than the rest of Broward. We could reference the other data.
- The Dial Cordy data is similar and different because of sample size. Look at the larger data set. Don't use an injured baseline.
- DEP applies their analysis to the optimum state and the current state and generally mitigates using the current state.
- It is incumbent to mitigate using the current state.
- HEA focuses on the current.
- Does the sample have suitable replicatable sites?
- Ken did a report. Bill did more analysis and rarefaction curves were flat with no inkling of coming up. This means that more samples would not help.
- We are nibbling at numbers.
- We need to compare this with and without the project. It won't get better as a comparison.
- The geographic area has changed.
- If you are looking for rare species or to characterize an area the sampling process will be different.
- The large corals are probably not there or are very rare.
- I have seen ½ meter deploria on this site.

There was a suggestion to use 50 years for 5-15% recovery and
0 years for 0 % recovery and everyone agreed.

10 - Shape of Recovery Trajectory

At the last meeting the group agreed to use a linear trajectory because it is clearer and simpler even though the actual trajectory may be slightly sigmoid.

12 - Discount Rate Per Time Unit (%)

Comments

- 3% was used because this is the figure required by USACE.
- There are legal precedents for using 3 %
- 6% is suggested based on a NOAA study. This is appropriate if there is a higher social value as indicated in the economic study of reef resources. A review of the studies yielded the 6% figure.
- 3% was used in the Florida Keys National Marine Sanctuary, Key West and other projects. It was also used in a Yellowstone Park project that had high social values.
- 3% is the USACE regulatory standard. There is a question about the real rate of interest versus the nominal rate. NOAA used 3% or the government-borrowing rate that is 3%.
- There is a social rate of time preference – NOAA has a memo on the 3% rate.
- NOAA also says an alternative rate may be used. People of Broward want the payback sooner.
- This is one of the two biggest factors.
- Historically the discount rate is 6%.
- NOAA is not stuck with 3% but there needs to be a clear rationale for anything different.
- The USACE rationale is the same as NOAA. We went with 3% because it would stand up in court and we can justify it to our clients.
- FWS used 3% and so does the DOI.
- I spoke to Grace Johns after arguments for more than 3%.
- Does the public use the area in the ship channel? People don't dive there but they do fish near by.
- DEP is working with 6% in current cases.
- Marie Burns asked for justification for the 6%
- This is new territory. The 3% needs to be looked at because situation has changed since it was first used.

There are the acceptability ratings for using 3 and 6%.

3%

	3	2	1
ACE	X		
FWC		X	
Co EPD		X	
FWS		X	
EPA		X	
NOAA		X	
DEP			X
NOVA			1.5

6%

	3	2	1
ACE			X
FWC		X	
Co EPD	X		
FWS	X		
EPA		X	
NOAA		X	
DEP	X		
NOVA		X	

13 - Date of compensatory action

- This starts with construction

14 - Type of compensatory action

- We asked if we could propose options and the answer was that there was no need for a plan. The resource agencies said that water quality improvements could be used. The decision was to do calculations based on using boulders and then use the funding for boulders and other alternatives to be specified at a later date.
- We need a set of alternatives, locations and materials. The resource agencies may have some suggestions for in-kind, on-site and out-of-kind actions.
- It is good to use boulders for calculations and then have a suite of agreed upon actions.
- Could money be given to the eco-system trust fund?
- We may not be able to commit funds to do that.
- We could give funds to a suite of actions.
- The USACE has more flexibility and is encouraged to explore options, e.g. a mitigation bank.
- We don't know the alternatives so we shouldn't choose them yet.
- We want to save resources in front of the dredge. We need at least enough boulders to place the salvaged corals.
- HEA requires scaling. If we remove boulders it will change the injury (compensation for the injury?).
- There needs to be a placeholder in the report that specifies that changes in the plan will require a collective decision.
- The Port uses an enterprise fund. If there are additional projects there will limits on what can be done.
- Funds could be used for mitigation.
- These dollars can't be mingled with Broward County funds.

At the end of the discussion the group agreed to use boulders for the compensatory action.

15 - Pre-Restoration Service Level (%)

- Boulders go on sand that has a value that will be a cost. We can give it a negative or deduct it from the value of the boulders. See if there are other pre-approved areas.
- The USACE hasn't approved Broward County sites but may.
- Filling borrow pits is a possibility but we can only count the surface not the volume. It would be a waste of boulders.
- It may be too expensive to fill some pits but some may not be too deep.
- We can work with the County to pick the best sites.
- In Biscayne Bay pits were filled and covered with sand to restore sea grasses. This hasn't been cost out.
- NOAA is interested in fisheries habitat in the pits.
- The goal is to pick places with the least impact. There is lots of sand there.

It was agreed to use 0% for the pre-restoration service level.

16 - Service Level of Compensatory Action Upon Initial Installation
(Of designed boulder placement)

- A 20% credit was given for boulder placement in the Kolar and Dodge study that has been sited.
- This was arrived at by a group for a different habitat not by the scientists. 5% would be good. The Hillsborough case was for a different injury. The study was a draft that was not finalized.
- We can review other HEAs that were accepted.
- There have been HEAs that used 20%, some without transplantation and with long linear inputs.
- We may not have to consider historic cases. Consider the services it provides on horizontal and vertical surfaces that are similar to a reef. Rocks provide some services.
- It provides habitat but not places for foraging.
- Fish and other species may take time.
- Are we looking at the biological or physical or both?
- Boulders are not the be all and end all. Boulders are more complex. Many projects use boulders, e.g. Bal Harbor where credit is given and utilization is demonstrated. 20% is widely used and peer reviewed. Whether we use 5 or 20% will not change the numbers much. I am just trying to get quicker recovery.
- Using alternatives to boulders may negate this. Use 5% to be conservative. Boulders provide more complexity and thus more services.
- The date starts the day the project ends.
- This would be a year.
- Past numbers have been thrown in projects. We should use the true numbers.
- There are fish functions with boulder projects. On the site we looked at there are fish and now corals are coming in. In 8 years it should be 5-10%
- 20% may be OK if constructed before the injury.
- The rock at the third reef is not good. 5% is a better figure.
- The boulders are from blasting.

- How well do past situations compare to here?
- May not separate biological and physical services. Work services into 2-5 years and increases.
- Bill will evaluate the third reef and design the project. 5-10% can be used if the complexity is the same and possibly more if there is more complexity. It will be necessary to specify the size and placement of boulders to get benefits as compared to natural areas.
- The USACE suggests using 10%.
- What about transplantation?
- This doesn't apply.
- We can't have more mitigation later so I want it to be 10%.
- The USACE can go 20% over the project cost (902) and this can be used for mitigation and other overruns. It is not available at the feasibility level.
- It may be inappropriate to take absolute worse case scenarios for a plan. We should use the best estimate and use adaptive management. We don't know everything. We can adjust if we have new information. We can learn a lot in 5-10 years. Let's go for the best. We don't know about translocation.
- We have learned about not taking the current case. Things always go wrong and we are told there is no money. We have learned from experience to anticipate the worst case.
- Then do we calculate the best possible economic possibilities?
- Provide a plan for translocation.
- We don't know enough about the bottom.
- Will the 20% extra be available?
- Congress allows us to increase the project cost by 20% without reauthorization. It must be justified.
- There is a required monitoring program. What happens if the mitigation is failing? PBSJ had to mitigate for failures. Dave did a study of success rates. There will be 1000's of translocated corals, maybe 20 species. We have an idea for what we will be moving.
- All of this will be part of the mitigation plan.
- It will also be written into the state permit.
- This is messy and difficult. We will consider 5-10% and make judgments. We want to do this together
- It would be good to have the information Bill gave earlier and to look at other information too.
- Let's try 5%.
- We don't have information so it is important to be conservative.
- Date will be for when the compensatory action is done.
- If you could go negative it would be considered.
- Why would you do this?

The following are the acceptability ratings for 0 and 5% for service level of compensatory action upon initial installation.

16 – 0%

	3	2	1

ACE			X
FWC		X	
Co EPD		X	
FWS		X	
EPA		X	
NOAA		X	
DEP	X		
NOVA		X	

16 -5%

	3	2	1
ACE		X	
FWC	X		
Co EPD	X		
FWS	X		
EPA	X		
NOAA		X	
DEP		X	
NOVA	X		

17 - Equilibrium level of service from CA expected
(For boulders with specified transplants)
18 - Time for services to develop from installation to equilibrium

- The initial should be 100%
- Almost 100% not attainment. There may be a rich community but it will not replace what was there.
- The use of parameters requires breaking complex systems down to simple measures. We have chosen coral that is at 1%. We could be centered on key species as in UMAM. In a HEA we are not looking at 10,000 functions. The question is whether we will we get to a level compared to current conditions.
- We should use the same metric as for impacts – corals.
- Are we assuming transplantation?
- Give the USACE specifications.
- Is it over 15 cm or 8-10 cm? This relates to survival.
- There may be 60-80,000 corals. It takes a lot of time and expense to transplant all of these. We need the USACE to provide the number and costs.
- There are only 20 A in the dredge area. We can give you approximate numbers.
- We don't have numbers for the wall.
- The USACE is not translocating all corals, just over a certain size based on the success rate. It may not make sense to move corals with a 10% success rate.
- All have some success rate (0-90%). We have to try.

Richard Dodge presented a PowerPoint on coral age and size over time.

- 75-100 years depending on size.

- The Dodge paper was not used in the HEA. There was a case study.
- 10% immediate for boulder with transplants
- Age distribution changes over time
- Only transplant 48%.
- When we do age calculations we have greater than 16 cm. 80% less than 10 cm so the curve will be shorter.
- We haven't defined other services. The use of corals may miss services. We may need a different proxy.
- 50 years without translocation. There may be 40 cm corals that are 50 years old. We can't have recovery less than the age of the oldest coral.
- If you remove corals and place them on boulders, those that survive would start immediately and there will be new corals forming.
- The initial numbers were run with transplantation of corals greater than 15 cm. Without transplantation it would be longer.
- It would be 65 years without transplantation based on a growth rate of .25 cm per year.
- Bill did not use a start from nothing. The number was pulled from other HEAs and other numbers to get an equilibrium factor. It is imperative to move large corals. Look at the population and mortality of all the corals, not one coral.
- It is costly to relocate corals and the USACE is committed to do their best.
- There will be a scope of work in the EIS.
- If you don't transplant you need a bigger area.
- Another project transplanted 2000 corals in three weeks.
- Keep the without transplantation on the table. You will need to make an economic decision.
- Transplantation is essential.

These are the acceptability ratings for different combinations of the values for 17 and 18.

100% and 50 years

	3	2	1
ACE		X	
FWC			X
Co EPD			X
FWS			X
EPA			X
NOAA			X
DEP			X
NOVA			X

75% and 65 years

	3	2	1
ACE			X
FWC	X		
Co EPD	X		
FWS	X		

EPA	X		
NOAA	X		
DEP		X	
NOVA	X		

75% and 55 years

	3	2	1
ACE		X	
FWC			X
Co EPD		X	
FWS		X	
EPA		X	
NOAA		X	
DEP			1.5
NOVA		X	

- DEP gave a 2 to the 75%/65 year option based on the assumption that the transplantation costs may be too high and the USACE may not do as much of it.
- Success criteria will be in the EIS and UMAM.
- No mitigation achieves 100%.

Middle Reef Direct Impacts

The middle reef was discussed briefly and everyone agreed to use the same numbers as the outer reef even though the makeup is somewhat different.

2nd Reef Channel Walls Direct Impacts

INJURY		COMPENSATORY ACTION	
12. Claim year= Date of Injury	2012	21. Date of compensatory action	2012
13. Site name			
14. Type of injury (direct, indirect+)	Direct	22. Type of compensatory action	Boulders
15. # of injured area units	.3564A		
16. Pre-injury service level =100%	100%	23. Pre-restoration service level (%)	0%
17. Degree of service lost of resources immediately following injury (%)	100%	24. Service level of CA upon initial installation	5-10%
18. Value-injured/value restored=1	1		
19. Equilibrium level to which recovery can reach	85%	25. Equilibrium level of service From CA expected	75, 100
20. Injury recovery time to equilibrium	26 yr	26. Time for services to develop from installation to equilibrium	26
21. Shape of recovery trajectory=linear	Linear	27. Shape of trajectory to equilibrium services	Linear
22. Time units=years	Years	28. Time units=years	Years
23. Discount rate per time unit (%)	3-6%	29. Discount rate	3-6%

- Are the channel walls included with the floors at the second reef?
- Yes.
- The north wall is currently 385 SF and will be 592 SF afterwards. The south wall is 452 SF and will be 457 SF afterwards. There will be more wall area afterwards for recolonization. The existing wall has been there 26 years.
- Were there pre-dredge surveys?
- The pre and post surveys are on the FTP site and on the CD.
- Yes they will be required.
- Walt Goldberg did some studies.
- Dredges don't always go exactly where they were designed to go.
- The USACE will get information requested by NOAA, if possible.
- If there is a better number than 30 ft. let us know.
- Calculations assume a rectangular profile and a 9 ft. cutter head which is the largest in the US.
- Spudding may not be available.
- Anchors will be required to stay in the channel limits. They have to pay for damage.
- There may be impacts 3-5 feet above the cuts.

- We calculated 5 ft. in Miami.
- Collapses are possible. In Key West we had divers do a survey.
- Key West used a different type of dredge.
- Did the original slop between the permitted area and actual cut differ and will we have the same problem?
- The precision is better than it was 26 years ago.
- The USACE could allow 5' for over cut.
- This was done before DEP permitting.
- How was the calculation done?
- What about the wall outside the reef area?
- This is not significant. It has been dredged in the last 3 years.
- DEP has pictures of large corals.
- USACE has video surveys from 2000, 01 and 02. Terri confirmed that that there are no impacts on the bottom 9 feet.
- DEP's photos of corals are above this 9 feet.
- There have been collapses
- The wall is not straight.
- If you want more information on the channel walls look at the videos.

20 - Injury recovery time to equilibrium

- What would 100% look like? It would not be the historic natural system.
- Treat the wall as a natural wall.
- We know what has happened in 26 years and it will get better.
- We should consider 26 years as the terminal condition.
- This is an HEA. Assume that the reef and the wall are the same.
- They are separate (There was no objection).
- Use 75% because of recruitment.
- We can't apply a shifting baseline.
- The current condition is the baseline.
- We may have bigger ships and the conditions may be worse.
- Having a deeper channel may result in fewer impacts.
- What number should we use? The past is informative.
- If we look at compensation, the new wall will be the same. I can see more than 70%. We have what we replace.
- What is out there is not the only example. We could model it and get a number. We don't have good data for a model. Could use a best guess or use the hard data we have. I prefer the hard data.
- We need to look at the pre and post surveys.
- We haven't analyzed them yet.
- It would be nice to have surveys.
- Water quality will be better in the next 26 years. We have done sampling and the quality is significantly better.
- Our figures show worse water quality conditions. There will be bigger ships and less

recruitment.

25 –

- The new wall can't be counted for compensation. Boulders are the action.
- We will have more new area, about ¼ acres. The floor wall will be 45-55' long.
- This is not a significant addition.
- Any biological resources will be saved.
- The channel wall creation can be considered but it will be small.

27 –

- It will not be 26 years.
- We don't have data on what is there.
- What if we have had no transplants? It will be better with transplanting.
- There are 12-15 ships a day.
- DEP has identified some large corals.

Outer Reef Indirect Impacts

INJURY		COMPENSATORY ACTION	
37. Claim year= Date of Injury	2012	40. Date of compensatory action	2012
38. Site name		41.	
39. Type of injury (direct, indirect+)	Indirect	42. Type of compensatory action	Boulders
40. # of injured area units	28.26A	43.	
41. Pre-injury service level =100%	100	44. Pre-restoration service level (%)	0
42. Degree of service lost of resources immediately following injury (%)	2, 5%	45. Service level of CA upon initial installation	10
43. Value-injured/value restored=1	1	46.	
44. Equilibrium level to which recovery can reach	98%	47. Equilibrium level of service From CA expected	75,100
45. Injury recovery time to equilibrium	35, 75yr	48. Time for services to develop from installation to equilibrium (no transplantation)	50,75
46. Shape of recovery trajectory=linear	47. Linear	49. Shape of trajectory to equilibrium services	Linear
24. Time units=years	Years	50. Time units=years	Years
25. Discount rate per time unit (%)	3-6%	51. Discount rate	3-6%

- Anchoring outside the channel would be considered direct impacts to be addressed with a separate HEA.
- There will be no blasting in the outer reef. It may require clamshell equipment.
- Turbidity and sedimentation require a separate HEA. Sedimentation may cause mortality. Turbidity may have short or long term impacts on light.
- Monitoring data is 25 years old.
- We have hopper head dredging monitoring reports and for the Key West dredging. There is also a report on the 80-81 Port Everglades dredging.
- The results depend on the materials and the currents.
- There are 2 activities; dredging or blasting and the removal that may have scowl leakage and disposal discharges. (OSDM is 5 to 5 ½ miles out and has required permits and certifications). Data from Miami shows (ADCP) no problems.
- Will there be blasting, cutter heads or clamshells used?
- The worst turbidity was from dredging in the inter-coastal waterway. The USACE did some OM.
- The USACE predicts low impacts.
- Let's combine turbidity and sedimentation.
- We have data on turbidity and sedimentation.
- There is little impact on big corals. It is hard to evaluate the impact on small corals.
- Include monitoring to get data on impacts on small corals.
- There was some study done by NSU.
- Will the monitoring shutdown the project if the conditions are bad?
- Yes, it can be in the specifications, e.g. no disposal if the current changes.
- What is "immediate?" This needs to be defined.
- We need to revisit this when we have new numbers.
- Cutters suck up the material so there is little turbidity and sedimentation.
- We have before, during and after monitoring.

42 – [Degree of service lost of resources immediately following injury (%)?]

- Past monitoring data suggests a 1-2% figure. Bill used 5% to be conservative.
- 0% is more likely. 5% may be excessive with a cutter head dredge. It may be more with a hopper head but still with no impact. The numbers are below standard.

44 –

- There may be long-term impacts.

45 –

- If 5% and corals are killed we could average the 50-100 and use 75.
- There could be a loss of productivity with death.
- 5% is based on partial morbidity and mortality.
- We consider landscape and population with corals as a proxy.
- There was no mortality on three recent projects.

- We need to be consistent with other HEAs.
- On direct impacts we lost 100%.
- Does it take 75 years to recover 3%?
- Consistency is not an issue for transplantation.
- Distinguish morbidity from mortality to determine age. We are putting too much together.
- Let's run contingencies with two options. Take the money back if thee is no mortality. Consider 2 and 75 and 5 and 35.
- What is the purpose of this? Don't we have to decide now?
- We need to address disposal and have a margin of error discussion. Expansion would require an EIS.
- We have to evaluate water quality.
- Is it OK if EPA addresses this in the OMDES?

What do you need before the next meeting?

1. What are the predicted impacts of the construction activity? Where will you put the spud and anchor?
2. Need a list of all the impacts and activities causing the impacts to occur. Use CEQ definitions.
3. What are the temporal, geographic and spatial areas of impacts?
4. Review the September 10th list of issues, some based on information and lack of information. Use this table as a guide. ACE will send out a comment matrix with responses. Agencies will respond if it was adequate.
5. ACE needs to see if videos of the channel walls can be used.
6. Provide pre and post-bathy surveys. Pace may help.
7. Analysis of coral data, #/sq meter by class in 2^{nd} and 3^{rd} reef for transplanting. Consider which corals do better.
8. Want details on state plan from Shantel on Ecosystem Trust Fund.
9. Share court case information on discount rate.
10. Dave Gilliam and Bill will help with costs of relocation
11. Need letters from cooperating and non-cooperating agencies.
12. Rarefaction curve from Bill.

Appendix A

September 25 & 26, 2007

Port Everglades HEA Meeting Agenda

Meeting Locations

Sept 25 – Port Everglades Port Offices – Room 301

Sept 26 - Port Everglades Port Offices – First Floor Auditorium

September 25, 2007

0900-0915 **Opening**

Welcome and opening comments, Phil Allen, Port Director

Meeting agenda and guidelines

Introductions and expectations

0915-1015 **HEA Overview**

Presentation

1. Overview of benthic community/relic reef system of Broward County.
2. Reef study for EIS prepared by Dial Cordy for corps.
3. Using that info - compare to other Broward county and SE FL studies.
4. Development of HEA input parameters for corps study.
5. HEA mitigation needs - boulders, etc.
6. Locations of possible mitigation sites.

1015-1030 **Break**

1030-1045 **Meeting Objectives Clarification**

Present approval and appeal processes (HEA, ERP and others)

Consideration of other perspectives

Seeking agreement on objectives/products of this meeting

1045-1100 **Map and Table Selection and Specifications**

Evaluate map and table options and select one of each

Specify the boundaries, labels and other attributes

Identify priority polygons for discussion

1100-1130 **Input Parameters** (For any spreadsheet)

Test for acceptability on the NCRI parameters

Seek consensus on any proposed changes in the parameters

1130-1200 **Polygon Discussion and Consensus Seeking,** For each:

Test to see if there are problems with the parameters or assumptions

Clarify the problem (definitions, scientific method, data availability or quality)

Identify options to address the problem

Seek agreement on how to resolve the problem (HEA model input)

Determine next steps for points not resolved (Conditional model input?)

Identify decisions that can be generalized to all or similar polygons

1200-1300 **Lunch,** Ordered in or on-your-own

1300-1615 **Continue Discussion and Consensus Seeking**

1615-1630 **Closing**
Summary of activities and results
Refine the Day 2 agenda
Agree on assignments as appropriate

September 26, 2007

0900-0915 **Opening**
Opening comments, Glenn Wiltshire, Deputy Port Director
Share insights from overnight
Revise agenda if needed

0915-1200 **Continue Discussion and Consensus Seeking**

1200-1300 **Lunch,** Ordered in or on-your-own

1300-1400 **HEA Spreadsheet Discussion**
Consider models/spreadsheets to be used by USACE and others
Discuss the process for validating models/spreadsheets
Seek consensus on agency procedures and coordination
Identify next steps for still unresolved issues/assumptions

1400-1430 **Mitigation Options**
Identify options for out-of-kind and in-kind mitigation and the related costs
Solicit suggestions for preparing mitigation proposals

1430-1500 **Other issues**
Margin of error – mitigation and funding for unintended impacts

1500-1530 **Closing**
Summary of meeting activities, results and next steps
Concluding comments by participants
Meeting evaluation

Appendix B

Meeting Guidelines

The Facilitator's Role:

- Help structure and guide discussions
- Maintain a record of group products
- Assist in compiling the results of the workshop

The Participant's Role:

- Share in keeping to the agenda
- Be focused and concise - balance participation
- Ask questions and verify assumptions
- Express and acknowledge differing views - no attacks or stereotyping
- Make sure recording is accurate
- Seek shared understanding and "consensus solutions"
  - Test acceptability: 3 = Good, 2 = Concerned but can live with it, 1 = Opposed
  - Clarify concerns and supporting science
  - Suggest and seek agreement on refinements
  - Retest acceptability and record any needed next steps

September 25 – 26, 2007 HEA Potential Attendees list

Allan D. Sosnow – Port Everglades
Terri Jordan - USACE
Marie Burns - USACE
Dennis Barnett – USACE, SAD
Steve Ross - USACE
Dick Powell - USACE
Leah Oberlin – USACE RD (Phone)
Jason Evert – USACE Contractor
Bill Precht – USACE Contractor
Bill Kruczynski - USEPA
Ron Miedema - EPA
Pace Wilber – NOAA Fisheries - HCD
Jocelyn Karaszia - – NOAA Fisheries - HCD
Greg Piniak - NOAA
Steve Thur – NOAA (Phone)
Jeff Howe – FWS
Vladimir Kosymin - FLDEP
Steve Macleod - FLDEP
Chantal Collier – FLDEP - CAMA
~~Sid Level – FLDEP parks – JUL (maybe)~~
Lisa Gregg - FWC
Mike Callahan - FWC
Erin McDevitt – FWC
Steve Higgins – BCDPEP (phone)
Lou Fisher - BCDPEP
Ken Banks - BCDPEP
Richard Dodge - NCRI - NSU
Kevin Kohler - NCRI - NSU
David Gilliam - NCRI - NSU
Brian Walker - NCRI - NSU
Alison Moulding - NCRI – NSU

November 27, 2007

Port Everglades HEA Meeting Summary Report

Project Overview

The U.S. Army Corps of Engineers (USACE) is currently conducting a feasibility study for an expansion of Port Everglades, including deepening and widening the approach channel. The primary alternative would cut through the second and third coral reefs tracts offshore of Fort Lauderdale, impacting several dozen acres of hard bottom benthic communities. Dial Cordy and Associates Inc. (DCA) was contracted by the Jacksonville District Army Corps of Engineers to aid in the preparation of the habitat equivalency analysis (HEA) for mitigation plan development for the project. In addition, the USACE convened a panel of invited experts (a.k.a. "Core Group") to assist USACE in using HEA to determine the quantity of mitigation that would be required for this project.

The HEA method is specifically used in cases of habitat injury when the service of the injured area is ecologically equivalent to the service that will be provided by the replacement habitat.
This approach is termed "service-to-service" (Strange 2002) and assumes the public is willing to accept a one-to-one trade-off between the service lost and the service gained by the restoration (NOAA 1997). HEAs are by necessity, simplified representations of very complex ecosystems. Also, multiple types of injuries can be quantified in an equivalent manner through the use of HEA (Dunford et al. 2004). For marine environments the HEA method has been successfully applied to vessel groundings on coral reefs (Milon and Dodge 2001), and seagrass damage cases (Fonseca et al. 1998; Fonseca et al. 2000).

Habitat equivalency analysis is specifically designed to determine the compensation the public is due to reconcile injuries to the ecosystem and the lost services the ecosystem provides to the biotic component. King (1997) noted, "when injured resources and/or services are primarily of indirect human use the appropriate basis for evaluating and scaling the restoration is HEA." The public is considered to have been made whole for ecological losses when the scale of restoration needed to offset losses of resources and services is achieved. HEA establishes the discounted service acre year (DSAY) as the "common currency" for comparison of the public's value of past injury and future restoration in a common time frame (Julius 1999). One service acre year is defined as the ecological service provided by one acre in one year. Economic discounting is used to express past injury and future restoration units in a common time (Julius 1999). So, one DSAY is the service provided by one acre in one year "discounted" to net present value. Area of injured habitat, percent loss of ecological services, duration of injury, are considered in HEA to determine DSAYs.

Cumulative DSAYs earned for a particular restoration project are dependent upon the type of habitat that is restored, the increase in habitat services offered as a result of restoration construction, and the amount of time over which services are provided by the restored habitat. The DSAYs earned over the duration of the restoration project are then translated to present time using a 3 percent discount rate (see discussion of selection of discount rate in the report).

Meeting Summary

Opening

This report is on the meeting held at Port Everglades in Fort Lauderdale on November 27, 2007. Everyone was welcomed and given a chance to introduce themselves and indicate who they represented. There are lists of the participants and meeting guidelines in Appendix A. The September 25-26 Meeting Report and Meeting Worksheets were distributed. The proposed meeting plan was to take up the issues that were not addressed at the first meeting and then to revisit unresolved issues from the first meeting if time permitted. Coral relocation and sea grass impacts were added to the initial list of unaddressed issues.

Unaddressed issues

1. Indirect impacts on the second reef from construction related sedimentation & turbidity (see worksheet)
2. Direct impacts of anchoring (see worksheet)
3. Mitigation of channel floor impacts
4. Additional parameters for indirect impacts (sedimentation and turbidity)
5. Additional parameters for anchoring impacts
6. Alternative mitigation strategies and criteria
7. HEA runs
8. *Coral relocation information*
9. *EIS and sea grass impacts*

The USACE restated that the question of channel floor impacts (3) was not open for discussion. Others stated that this was still an issue for them. When the question of additional parameters (4 and 5) was raised, no one had any to add. The group agreed that additional mitigation strategies (6) need to be addressed if time permits. The HEA runs (7) were to be considered as part of the discussions of impacts. The coral relocation information (8) was discussed briefly. It was acknowledged that the sea grass impacts (9) will be addressed in the EIS process and would not be covered at this meeting.

Middle Reef Sedimentation/Turbidity Impacts (Indirect)

(Note that Sedimentation/Turbidity Indirect Impacts to the Outer Reef were discussed at the Sept 25-26 meeting).

The values below in normal font were proposed by the USACE for consideration by the group. The values in *italics* are alternate values proposed by other members of the group and this indicates that there is not consensus on the value for that parameter. Notes from the discussions of the parameter values follow the table

INJURY		COMPENSATORY ACTION	
1. Claim year= Date of Injury	2012	13. Date of compensatory action	2012
2. Site name			
3. Type of injury (direct, indirect)	Indirect sed/turb	14. Type of compensatory action	Boulders
4. # of injured area units	15.89		
5. Pre-injury service level	100%	15. Pre-restoration service level (%)	0%
6. Degree of service lost of resources immediately following injury (%)	5%	16. Service level of CA upon initial installation	~~10 %~~ *0-5%*
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	98%	17. Equilibrium level of service From CA expected	100% *75%*
9. Injury recovery time to equilibrium	35 yrs *15 yrs*	18. Time for services to develop from installation to equilibrium	50 yrs *75 yrs*
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit (%)	3%, *6%*	21. Discount rate per time unit (%)	3%, *6%*

4. # of injured area units (15.89)

- This number may be affected by anchoring. The area of anchoring impacts may need to be subtracted to avoid double counting.

5. Pre-injury service level (100%)

- 100% is based on the current stress. It is a baseline.

6. Degree of service lost of resources immediately following injury (5%)

- Should we separate turbidity and sedimentation?
- We agreed at the last meeting to consider them together.
- Are we talking about morbidity and/or mortality
- We need a definition of the service level, the USACE considered morbidity. It has been

dredged before. It will be the same. There will be some morbidity but no mortality.

- What does the 5% mean?
- It is not 100%. There is some stress. We have limited scientific data.
- It is the % of stress.
- It should be 5% for 35 years.
- I am OK with the 5% but I am not sure what it means.
- If this is a problem it will be addressed.
- Monitoring shows no effect in terms of mortality or morbidity (stress).
- This does not include the possibility of an unforeseen accident or problem.

8. Equilibrium level to which recovery can reach (98%)

- Are there any stresses?
- The biomarker study shows the impact of outlets (stress); there is no mortality or stress.
- 98% indicates some turbidity and sedimentation from ship traffic.
- There may be less impact because of the deeper channel and fewer ships.
- Currently there is no channel on the 2nd and 3rd reef. With a channel there will be decreased clarity. There will be no hard bottom to buffer the currents.

9. Injury recovery time to equilibrium (35 yrs or *15 yrs*)

- It should be 10-15, not 35 years because of morbidity.
- It should be 35 years.
- Hasn't the impact already been addressed?
- We should focus on sedimentation and turbidity from construction not from ships.
- Recovery is to 98% not 100%.
- The corals are also impacted by poor water quality and other causes.
- We could do a turbidity impact ships estimate.
- Let's use 15 and 35 in a sensitivity analysis to be run by NOAA. (Estimated less than 1% of the mitigation area.) Include scenarios in an appendix in NEPA so the public can see the outcomes. It may convey a low impact. The USACE will do others.
- How do we capture the impact of larger ships?
- Lori Hadley with the USACE can do a simulation.
- This can be addressed in "cumulative impacts" in NEPA not the HEA.
- The USACE is not accountable for impacts that it does not control and reasons for longer time to equilibrium will be addressed in the cumulative impacts section of the EIS, not used in HEA as vessel operations post-construction cannot be accounted for in Corps analyses according to policy
- Not all USACE districts agree on this position.
- When we do an HEA the impacts are broken down into simple metrics/impacts. We have field evidence, peer reviewed evidence and best professional judgments.
- There are gaps in the science, and there will always be gaps.
- It is hard to distinguish stress from mortality. It could be more than 35 years. We can't just separate out construction impacts.
- Just the construction impacts happen early and diminish in 2-3 years to close to the

background level. We have to consider previous construction as a baseline, i.e., max value; this was 28 years ago.

- It should be based on recovery from construction not ship traffic.
- Sensitivity between 35% and 15% is 1% of mitigation acreage.
- In scoring FWS did not consider cumulative impacts, but only construction (direct) impacts
- NOAA considered long-term impacts
- DEP and NSU noted construction only, but indicated that long-term is part of that

Acceptability ratings for 15 vs. 35 yrs for #9. Injury recovery time to equilibrium
Rating Scale: 3 = Good, 2 = Concerned but can live with it, 1 = Opposed

15 years	3	2	1		35 years	3	2	1
ACE	X				ACE			X
FWC			X		FWC		X	
Co EPD	X				Co EPD		X	
FWS	X				FWS		X	
EPA					EPA			
NOAA		X			NOAA	X		
DEP			X		DEP	X		
NSU			X		NSU	X		

16. Service level of CA upon initial installation (~~10%~~, *0-5%*)

- [After some discussion, it was agreed to use the same figures as for the outer reef]

12, 17, 18 and 21.

- [There was still not agreement on these values that were discussed extensively at the last meeting and no new information was offered.]
- DEP provided a document for Corps review at the meeting, re: discount rates via e-mail prior to the meeting

Direct Impacts of Anchoring

The values below in normal font were proposed by the USACE for consideration by the group. The values in *italics* are alternate values proposed by other members of the group and this indicates that there is not consensus on the value for that parameter. Notes from the discussions of the parameter values follow the table

Combination of areas in the Inner, Middle, and Outer reefs

INJURY		**COMPENSATORY ACTION**	
1. Claim year= Date of Injury	2012	13. Date of compensatory action	2012
2. Site name	Anchor-cable		
3. Type of injury (direct, indirect)	Direct - anchor/cable	14. Type of compensatory action	Boulders
4. # of injured area units	11.91 A (1) *17.15 A*		
5. Pre-injury service level	100 %	15. Pre-restoration service level	0%
6. Degree of service lost of resources immediately following injury (mortality)	50% (2)	16. Service level of CA upon initial installation	10% (3) *0-5%*
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	98% *85-95%*	17. Equilibrium level of service From CA expected	100% (4) *75%*
9. Injury recovery time to equilibrium	50 years (5) *100 years*	18. Time for services to develop from installation to equilibrium	35 yrs w/transplants or 50, *75* yrs without (6)
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit	3% (7) *6%*	21. Discount rate per time unit (%)	3% (8) *6%*

4. # of injured area units (11.91, *17.15 A*)

- Nova Southeastern University, NSU, has done a GIS analysis of the area impacted and Broward County is doing numbers. [A map with a table of calculations by area was distributed and is available at the project ftp site.]
- Anchorage direct impacts may change, i.e., decrease, indirect impacts acreage
- The USACE won't include the Rubble Shoal and Submerged Breakwater areas. Terri Jordan will check with the USACE.
- Artificial reefs have a quality of environmental services.

- The USACE does not mitigate for navigational structures.
- In another case they did not mitigate but did transplant corals.
- What is DEP's policy? Does new construction need mitigation, not maintenance? We would consider it on existing resources. There would be no dinging for past impacts.
- Kevin's and USACE's numbers match 12.61 plus 4.51 = 17.151 without the rubble shoal and breakwater. This would be a policy call.
- Pace will talk to Marie.

6. Degree of service lost of resources immediately following injury <u>(mortality/morbidity)</u> (50%)

- Based on the experience in Miami Harbor Phase 2 there were no impacts.
- 50% loss in the triangle areas is used to be conservative.
- There was a 25% (but Corps used a more conservative 50%) impact in Hillsborough where the tugs drug the cables.
- In Miami the cables were pontooned so the impact was 0.
- Vlad recalls damage between two ships not the cutter heads.
- Steve Bair and DERM did monitoring in Miami. There were no cable or anchor impacts.
- We will use a "you break it, your buy it" clause in the contracts as an incentive as we did in Miami. The USACE will require use of the best available technology. Cutter heads are assumed. This is the only technology that will work. We want to calculate the mitigation and then not need it.
- What does 50% mean, 50% mortality or 50% morbidity?
- 50% morbidity was used.
- If they do a great job this page is irrelevant. If the damage is less than 50% we can claim a mitigation credit. If it is greater than 50% the contractor pays.
- This doesn't set a cap on mitigation. The contractor will pay for any additional mitigation.
- Consider requiring a bond for mitigation. The USACE will check on this.
- The USACE and DEP MOU address this as part of "water quality."

8. Equilibrium level to which recovery can reach (98%, *85-95%)*

- Vlad suggests 85% given the rate of recovery, like the channel walls.
- The walls were 85% because of possible caving so this doesn't apply. Caving has not been documented previously at Port Everglades or in the recent Port of Miami. Have to use the available data and comparisons where available.
- 95% may be a better number.

9. Injury recovery time to equilibrium (50 years, *100 years)*

- Should be 100 yrs.
- There are no 100-year corals out there based on the survey. [The USACE wants to use 50 years and others prefer 100 years]

13-21 The discussion of values would be the same as for the sedimentation/turbidity table.

Mitigation Options

An initial list of possible mitigation was presented for discussion based on responses to the pre-meeting worksheet input and consultant suggestions.

Possible Mitigation Options

Boulders
Other types of artificial reefs (locations, including reef gaps & inter-reef soft bottoms, materials, configurations, depths, etc.)
Installing corals on existing substrates (def of "mitigation" vs. "avoid/min")
Water quality improvements
Remove spoil shoal north of channel
Remove spoil shoal south of channel
Removal of maintenance dredge material
Removal of tires from Middle Terrace/Reef
Mooring sites offshore

Possible Option Evaluation Criteria

A. Like-for-like resource benefit (i.e. In-kind)
B. A quantifiable estimation of the benefit
C. A reasonably established chance of success

Discussion Notes

- Like-to-like would be hard bottom to hard bottom in the region.
- The USACE is committed to transplant 13,000 corals.
- Are there artificial reefs in the area without corals?
- There are some but they are shallower and there are not enough.
- It would only be compensatory if it were new rock.
- NOAA would recognize some benefit from existing boulders.
- There are policy problems with using existing boulders.
- This is minimization of impacts and should be required.
- We need to get the HEA numbers for boulders.
- We need structure for structure removal on the outer reef, e.g. 20 acres for 20 acres.
- The mitigation cost estimates will be based on the use of boulders.
- Cost estimates based on boulders could be low.
- Once the calculation is made we can choose the best way to spend the funds and maximize the benefit.
- Should do HEAs for all mitigation options to ensure selected alternatives don't provide less value (Dodge)
- The result is a number for the federal share. Then the USACE can apply for the funds to the better options. The funds also come from the local sponsor. The estimate is the minimal habitat gain for the options.

- We are not locked into boulders forever. There may be more restoration options by 2020.
- Do a habitat gain and cost chart with an error range. This analysis will help in making decisions.
- We can use boulders as a placeholder in the draft mitigation plan that is part of the DEIS. The USACE will work with partners to develop a mitigation plan in the EIS and may create a mitigation bank. If the agencies & USACE cannot develop alternatives to boulders, then the Corps will rely on boulders as the mitigation tool for project.
- Are there sites that have not been restored?
- There are orphan sites and things that can be done.
- Come up with a wish list, e.g. install mooring balls could save 4 acres
- We need to be sure of the benefits.
- I am concerned about the cost estimate.
- The USACE has a rigorous estimating process. It seeks the best value to the government.
- Why use boulders? We scale the HEA based on projects we know.
- I am concerned about boulders. The outer reef rock may not be suitable (Fisher). Outer reef rock is not proposed to be used. The rock will come from the inside of the port and be excavated associated with the proposed blasting (Jordan).
- Can the USACE transfer funding for restoration to NOAA or the State Restoration Fund?
- NOAA doubts a MOA is possible. It could accept funding for specific purposes.
- Audubon has a restoration fund.
- We may be able to use the DEP fund but there are problems.
- FWC has no usable funds and there will be no new ones. There is always a danger that trust funds will be swept by the legislature. A private fund may be OK.
- There is a great administrative burden to set up a fund and there would need to be a trustee council to make the decisions.
- This is a new foray for the USACE. We have new tools.

The group agreed on these provisions:

- We will use boulders to do the mitigation cost estimates following the USACE policy on cost risk analysis for costs and contingencies. The local sponsor will be responsible for 50% plus monitoring, etc.
- The Delphi technique will be used to get input from the partners on priority mitigation options and criteria for evaluation. Questions will be sent out. Answers will be compiled anonymously and resent for comment.

Concluding Comments

At the end the facilitator offered each participant the opportunity to offer a concluding comment if the wanted to. These are the notes on their comments.

- It has been five years since the agency response. We want to avoid a public battle over the EIS. The USACE may want to consider requesting an agency response at this time. Agency participants could talk to their senior management and then send an advisory letter clarifying support and any areas of serious concerns.
- This can be talked about at the cooperating agency meeting on Thursday.
- It would be helpful if the letter identified what issues need more attention.
- A DEIS and EIS should be similar.
- The USACE will do a draft mitigation plan
- Based on regulation – the EIS should address substantive comments on the DEIS and thus, major changes between the Draft and Final EIS are possible and likely.
- We want to go through the NEPA process as smoothly as possible.
- Doing an agency letter is a good idea.
- There is always a flurry of effort at the beginning and end of these processes.
- The USACE has worked on this project for years. There is much work that has been done. Don't assume that nothing has been done. Check with your previous staff and agency files for meeting minutes, e-mails, phone call records, etc. before criticizing the past process and writing "advisory" letters.
- We may have a concurrent 10-point process. There are many ways to do this. (Pace Wilber referencing the port of Savannah's methodology for their expansion project).
- There were project delays and staff changes. The USACE wants the cooperating agencies to be co-authors and partners.

Appendix A

Meeting Participants

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Meeting Guidelines

The Facilitator's Role:

1. Help structure and guide discussions
2. Maintain a record of group products
3. Assist in compiling the results of the workshop

The Participant's Role:

1. Share in keeping to the agenda
2. Be focused and concise - balance participation
3. Ask questions and verify assumptions
4. Express and acknowledge differing views - no attacks or stereotyping
5. Make sure recording is accurate
6. Seek shared understanding and "consensus solutions"
   a. Test acceptability: 3 = Good, 2 = Concerned but can live with it, 1 = Opposed
   b. Clarify concerns and supporting science
   c. Suggest and seek agreement on refinements
   d. Retest acceptability and record any needed next steps

Appendix B

Pre-Meeting Worksheets

With Input from Richard Dodge

Richard Dodge's comments below are referenced in brackets in the table.
Combination of areas in the Inner, Middle, and Outer reefs

INJURY		**COMPENSATORY ACTION**	
13. Claim year= Date of Injury	2012	22. Date of compensatory action	2012
14. Site name	Anchor/cable		
15. Type of injury (direct, indirect)	Direct - anchor/cable	23. Type of compensatory action	Boulders
16. # of injured area units	11.91 A (1)		
17. Pre-injury service level	100	24. Pre-restoration service level	0%
18. Degree of service lost of resources immediately following injury (%)	50% (2)	25. Service level of CA upon initial installation	10%, (3)
19. Value-injured/value restored=1	1		
20. Equilibrium level to which recovery can reach	98%	26. Equilibrium level of service From CA expected	100% (4)
21. Injury recovery time to equilibrium	50 years (5)	27. Time for services to develop from installation to equilibrium	35 years w/transplants or 50 w/o(6)
22. Shape of recovery trajectory=linear	Linear	28. Shape of trajectory to equilibrium services	Linear
23. Time units=years	Years	29. Time units=years	Years
24. Discount rate per time unit	3% (7)	30. Discount rate per time unit	3% (8)

(1) (According to Terri's table supplied on the FTP site, this is the area figure for the Inlet Channel. It is not a combo area of the impact to reefs. The sum of Inner, Middle, and Outer impact area is 12.61 a. Please explain how the 11.91 figure was obtained.)
(2) (This should be 100%. The anchor and chain scrape the substrate completely bare and so there is a de facto 100% loss.)
(3) (This should be 0% or at most 5%)
(4) (This should be 75% to be consistent with previous discussions. 50% is preferable)
(5) (This should be 100 years)
(6) (This should be 75 years without transplants and 65 years with. Where are the transplants coming from? Is the ACE proposing to remove all corals from expected anchor areas?)
(7) (This should be 6%)
(8) (This should be 6%)

Summary Table Prepared by Richard Dodge

TABLE OF Anchor and Anchor Chain Impacts		
Habitat	Sq ft	Acre
Outer Reef	219904.87	5.048
Channel Wall	515226.34	11.828
Middle Reef	204508.23	4.695
Inner Reef	124842.51	2.866
Nearshore HB	197795.83	4.541
Rubble Shoal	22386.38	0.514
Submerged Breakwater	54518.13	1.252
Sand	647803.03	14.871

The HEA Results – For discussion use only

Injury Category	Area (Acres)	Initial Service Loss	Equi Servi(
1. Middle and Outer Reef Direct Impacts- Recovery to 0%	20.34	100	
2. Middle and Outer Reef Direct Impacts- Recovery to 5%	20.34	100	
3. Middle and Outer Reef Direct Impacts- Recovery to 15%	20.34	100	
4. Middle Reef Channel Wall- Recovery to 85%	0.3654	100	
5. Middle Reef Channel Wall- Recovery to 95%	0.3654	100	
6. Turbidity All 3 Reefs & HB- 2% loss, perpetual loss (no recovery)	80.35	2	
7. Turbidity All 3 Reefs & HB- 5% loss, 35 year recovery	80.35	5	

Injury Category	Area (Acres)	Initial Service Loss	Equilibrium Service Level
1. Middle and Outer Reef Direct Impacts- Recovery to 0%	20.34	100	0
2. Middle and Outer Reef Direct Impacts- Recovery to 5%	20.34	100	5
3. Middle and Outer Reef Direct Impacts- Recovery to 15%	20.34	100	15
4. Middle Reef Channel Wall- Recovery to 85%	0.3654	100	85
5. Middle Reef Channel Wall- Recovery to 95%	0.3654	100	95
6. Turbidity All 3 Reefs & HB- 2% loss, perpetual loss (no recovery)	80.35	2	98
7. Turbidity All 3 Reefs & HB- 5% loss, 35 year recovery	80.35	5	98

Restoration Requirement Matrix (in acres)

Comp HEA \ Injury HEA	1	2	3	4	5	6	7
8	35.68	34.75	32.89				
9	51.39	50.05	47.36				
10	56.35	54.88	51.94				
11				0.20	0.17		
12				0.28	0.23		
13						2.82	4.41
14						4.85	7.59

Summary
Direct Reef Impacts: 32.89 to 56.35 acres
Channel Wall Impacts: 0.17 to 0.28 acres
Turbidity Impacts: 2.82 to 7.59 acres

min* 35.88
max* 64.22

*Caveats associated with HEAs
1) The results of these HEAs are based on a range of parameters and they are considered draft HEAs.
2) The draft HEAs represent a summation of three injury categories ONLY.
3) The HEAs are not representative of the total restoration requirement
In order to develop a more complete restoration requirement, discussion is needed on the remaining reef injury categories, in addition to mangrove and seagrass injury categories.

Richard Dodge Pre-Meeting Worksheet Comments on the HEA Runs

- The HEA runs are also incomplete.
- The HEA has no output for the case of 6% discount rate. 6% was the preferred rate according to the Rating
- The HEA has no output for the case for 0% initial services for the CA. This was a valid case to be examined.

- **We need to "vote" on 4 vs. 5:**
  4. Middle Reef Channel Wall- Recovery to 85%
  5. Middle Reef Channel Wall- Recovery to 95%
- **We need to "vote" on 6 vs. 7:**
  6. Turbidity All 3 Reefs & HB- 2% loss, perpetual loss (no recovery)
  7. Turbidity All 3 Reefs & HB- 5% loss, 35-year recovery
- **We need to "vote" on 11 vs. 12:**
  11. Boulders for Channel Wall Impacts- 10% initial, 100% max, 26 years
  12. Boulders for Direct Reef Impacts- 5% initial, 75% max, 26 years
- **We need to "vote" on 13 vs. 14:**
  13. Boulders for Turbidity Impacts- 10% initial, 100% max, 50 years
  14. Boulders for Turbidity Impacts- 5% initial, 75% max, 75 years

Unresolved Direct Impact Values from the Last Meeting

These are the parameters and alternative values developed at the last meeting with selected references to science and professional judgments from the meeting report.

8. Equilibrium level to which recovery can reach
Direct Impacts to Outer and Middle reefs *0, 5 or 15%*

Science and professional judgment supporting 0%

- Look at areas where outfall pipes were installed, there are not resources there.
- We don't know what will happen in the future. From the Keys it will be closer to 0% than 15 %. The channel that was dredged in Key West is a wasteland and is stirred up regularly.
- In the time relevant to the HEA calculations (e.g., ~300 years), there will be effectively no recovery of the injured reef towards its former state. Hence 0% is the most reasonable figure. RD
- It boggles the mind to propose a recovery number greater than 0% for a reef that is effectively obliterated and removed. The reef has been removed. It is missing! While there may be a small number of living organisms that colonize the channel floor over time, it is difficult to imagine a return to services of anything like 5% and certainly not 15%. If pressed, a 0.5% recovery is possible to give a nod to very minor recovery. RD

Science and professional judgment supporting 5%

- We can conjure up envelops of reasonableness with in the range of 5-15%. We are not sure where we are. We can do histograms that would help us understand. It bothers us to say, "We can live with it." The closer we get to 0 the less significant it is.

Science and professional judgment supporting 15%

- We looked at the recovery on the second reef in 26 years and it is about 5% now and may reach 15% in 50 years.
- The Middle reef is not comparable to the Outer reef.
- 15% seems good because Bill and others looked at recovery on reef 2 **[was this the**

channel floor??] after 26 years and considered 3 in 50 years. Why not?

- We are only looking at the bottom not the sides.
- Most of the corals are brooding species and we will have more recruits over time. Equilibrium may not happen for 100 years.

We already "voted" on the above for Direct Outer and Middle. RD

9. Injury recovery time to equilibrium

Direct Impacts to Outer and Middle reefs *50 yr for 5-15% or 0 yr. for 0%*

Science and professional judgment supporting 50 yr for 5-15%

- Bill used 35 years. 95-97% of corals were in a type/size of 20-25 cm. It took 35 years to achieve the size and density. 50 years was conservative. The difference between 35 to 50 is not that much.
- Past HEA's are set at 35 years because of what one attorney did in one case and it has been sited ever since. We have better information now.
- The oldest corals are about 100 years old. We should use that timeframe.
- Dr. Dodge's PowerPoint showed his interpretation of coral age in Broward County.
- On-site all corals on the third reef were less than 40 cm (with a conservative growth rate).
- There was an inadequate sample size. Dodge's sample was larger.
- I ran the numbers for 5% for 100 years and 15% for 50 years and there is only a 6% difference in the results. We need to put this parameter into perspective.

12. Discount rate per time unit

Direct outer and middle reefs *3 or 6%*
Direct channel wall impacts, 3 or 6%

Science and professional judgment supporting 3%

- 3% was used because this is the figure required by USACE. **[Where is the statute that says 3% is required? Please provide this RD]**
- There are legal precedents for using 3%
- 3% was used in the Florida Keys National Marine Sanctuary, Key West and other projects. It was also used in a Yellowstone Park project that had high social values.
- 3% is the USACE regulatory standard. There is a question about the real rate of interest versus the nominal rate. NOAA used 3% or the government-borrowing rate that is 3%.
- There is a social rate of time preference – NOAA has a memo on the 3% rate.
- FWS used 3% and so does the DOI.

Science and professional judgment supporting 6%

- 6% is suggested based on a NOAA study. This is appropriate if there is a higher social value as indicated in the economic study of reef resources. A review of the studies yielded the 6% figure.
- NOAA also says an alternative rate may be used. People of Broward want the payback sooner.
- State of Florida has used 6%.

16. Service level of compensatory action [of Direct?] upon initial installation (boulders) *0-5%*

<u>*Science and professional judgment supporting 0%*</u>

- It may be inappropriate to take absolute worse case scenarios for a plan. We should use the best estimate and use adaptive management. We don't know everything. We can adjust if we have new information. We can learn a lot in 5-10 years. Let's go for the best. We don't know about translocation.

<u>*Science and professional judgment supporting 5%*</u>

- A 20% credit was given for boulder placement in the Kohler and Dodge study that has been sited.
- This was arrived at by a group for a different habitat and not by the scientists. 5% would be good. The Hillsborough case was for a different type of injury. The study was a draft that was not finalized.
- There have been HEAs that used 20%, some without transplantation and with long linear inputs.
- We may not have to consider historic cases. Consider the services it provides on horizontal and vertical surfaces that are similar to a reef. Rocks provide some services.
- Boulders are not the be all and end all. Boulders are more complex. Many projects use boulders, e.g. Bal Harbor where credit is given and utilization is demonstrated. 20% is widely used and peer reviewed. Whether we use 5 or 20% will not change the numbers much. I am just trying to get quicker recovery.
- Using alternatives to boulders may negate this. Use 5% to be conservative. Boulders provide more complexity and thus more services.
- The rock at the third reef is not good. 5% is a better figure.
- Bill will evaluate the third reef and design the project. 5-10% can be used if the complexity is the same and possibly more if there is more complexity. It will be necessary to specify the size and placement of boulders to get benefits as compared to natural areas.
- The USACE suggests using 10%.

17. Equilibrium level of service from CA expected (boulders with transplants)
Direct outer and middle reefs, *75, 100%*
Channel Wall impact, *75 or 100%*

<u>*Science and professional judgment supporting 75%*</u>

- <u>75% is a compromise between 50% and 100% RD</u>
- <u>It is difficult to believe that the services of a pile of boulders will actually replicate the services of a reef to a level of more than 75%. RD</u>

<u>*Science and professional judgment supporting 100%*</u>

18. Time for services to develop on the CA from installation to equilibrium
Direct Impacts to Outer and Middle reefs, ***50, 55 or 65 years***

Science and professional judgment supporting 50 years

- 50 years without translocation. There may be 40 cm corals that are 50 years old. We can't have recovery less than the age of the oldest coral.

Science and professional judgment supporting 55 years

Science and professional judgment supporting 65 years

- Without any transplants, the CA would take at least as long to recover as the natural reef (that had no structural removal). This is 100 years without transplantation for the natural reef. 75 years was chosen because the recovery is only to 75% RD
- Richard Dodge presented a PowerPoint on coral age and size over time. 75-100 years depending on size.
- The estimate of recovery time with transplantation would be 65 years assuming 75 years without transplantation. RD
- Even though corals are the keystone organism, transplantation of the oldest age class does not convey enormous credit. Some credit is possible. RD
- DEP gave a 2 to the 75%/65 year option based on the assumption that the transplantation costs may be too high and the USACE may not do as much of it.

21. Discount rate

Direct outer and middle reefs *3 or 6%*
Channel wall impacts, *3 or 6%*

Science and professional judgment supporting 3%
Science and professional judgment supporting 6%

Unresolved Indirect Impact Values from the Last Meeting

These are the parameters and alternative values developed at the last meeting with references to science and professional judgments from the meeting report.

6. Degree of service lost of resources immediately following injury

Indirect (sedimentation/turbidity) Outer and Middle reef, *2 or 5%*

Science and professional judgment supporting 2%

- Past monitoring data suggests a 1-2% figure. Bill used 5% to be conservative.
- 0% is more likely. 5% may be excessive with a cutter head dredge. It may be more with a hopper head but still with no impact. The numbers are below standard.
- We have hopper dredging monitoring reports for the Key West and Broward County Shore protection project dredging.
- The results depend on the materials and the currents.
- There is little impact on big corals. It is hard to evaluate the impact on small corals.
- Include monitoring to get data on impacts on small corals.
- There was the Broward County Shore Protection Project study done by NSU.

- Cutters suck up the material so there is little turbidity and sedimentation.

Science and professional judgment supporting 5%
- Same as above

Science and professional judgment supporting some effects RD
- There needs to be some level of impact for sedimentation and turbidity above 0%. It is difficult to imagine that a large cutter head dredge deepening and widening the channel will generate no sedimentation and turbidity.
- What about turbidity generated by all the dredging within the Port when the interior is deepened and widened?
- John Proni's data shows that the same water often goes into and out of the port several times, thus the turbidity will likely be sucked in and out on multiple tidal cycles, exacerbating the problem.

9. Injury recovery time to equilibrium

Indirect Outer and middle reef, *35 or 75 years*

Science and professional judgment supporting 35 years
- There was no mortality on three recent projects.

Science and professional judgment supporting 75 years
- If 5% and corals are killed we could average the 50-100 and use 75 years.
- Does it take 75 years to recover 3%?
- An injury is an injury. The % injured refers to dead corals. Hence the time required is the time for coral replacement which we have previously estimated at ~75 years. RD

12. Discount rate per time unit
Indirect outer and middle reef, *3 or 6%*

Science and professional judgment supporting 3%
- 3% was used because this is the figure required by USACE. **[Where is the statute that says 3% is required? Please provide this RD]**
- There are legal precedents for using 3%
- 3% was used in the Florida Keys National Marine Sanctuary, Key West and other projects. It was also used in a Yellowstone Park project that had high social values.
- 3% is the USACE regulatory standard. There is a question about the real rate of interest versus the nominal rate. NOAA used 3% or the government-borrowing rate that is 3%.
- There is a social rate of time preference – NOAA has a memo on the 3% rate.
- FWS used 3% and so does the DOI.

Science and professional judgment supporting 6%
- 6% is suggested based on a NOAA study. This is appropriate if there is a higher social value as indicated in the economic study of reef resources. A review of the studies

yielded the 6% figure.

- NOAA also says an alternative rate may be used. People of Broward want the payback sooner.
- State of Florida has used 6%.

17. Equilibrium level of service from CA expected (boulders with transplants)

Indirect Outer and middle reef, *75 to 100%*

Science and professional judgment supporting 75%

- 75% is a compromise between 50% and 100% RD
- It is difficult to believe that the services of a pile of boulders will actually replicate the services of a reef to a level of more than 75%. RD

Science and professional judgment supporting 100%

18. Time for services to develop on the CA from installation to equilibrium

Indirect Outer and Middle reef, 50 or 75 years with transplantation

Science and professional judgment supporting 50 years

Science and professional judgment supporting 75 years

21. Discount rate

Indirect Outer and middle reef, *3 or 6%*

Science and professional judgment supporting 3%

Science and professional judgment supporting 6%

See comments under 12. (Note we already "voted" on this) RD

Resolution Status Summary Prepared by Richard Dodge

DIRECT TYPE	Resolution Status
Outer Reef	Partially
Middle Reef	Partially
Inlet Channel Floor	Partially
Sand	Not Yet Addressed

Sedimentation/Turbidity	
	Partially
Middle Reef	Partially
Inner Reef	Partially

Near Shore HB	
Rubble Shoal	Not Yet Addressed
Submerged Breakwater	Not Yet Addressed
Inlet Channel Wall	Partially
Sand	Not Yet Addressed
ANCHORING	
Outer Reef	Not Yet Addressed
Middle Reef	Not Yet Addressed
Inner Reef	Not Yet Addressed
Near shore HB	Not Yet Addressed
Rubble Shoal	Not Yet Addressed
Submerged Breakwater	Not Yet Addressed
Inlet Channel Wall	Not Yet Addressed
Sand	Not Yet Addressed

APPENDIX E-4

Draft Compensatory Mitigation Recommendations of the Port Everglades Reef Group for Navigation Improvements at Port Everglades Harbor (2004)

Recommendations of the Port Everglades Reef Group Regarding Compensatory Mitigation for Navigation Improvements at Port Everglades Harbor

Prepared for

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by

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17 May 2005

PREFACE

The U.S. Army Corps of Engineers is conducting a study to determine the feasibility of constructing navigation improvements at Port Everglades (Broward County, Florida). The goal of the Port Everglades Reef Group (PERG) was to elicit comments from participants (scientists, regulatory officials, and stakeholders) regarding what types of compensatory mitigation should be considered by the Corps, and how mitigation should be carried out in order to maximize benefits to the ecosystem and ensure long-term performance/benefits. PERG commenced deliberations on 12 June 2002 and suspended activity on 17 May 2005. Great care was taken to include all opinions and recommendations of PERG members. However, due to the limited scope of PERG, some were not included herein. PERG participants are encouraged to provide the Corps with any comments or opinions that were not included in this document. Readers are cautioned that the contents of the document provides draft conclusions based on hypothetical mitigation scenarios, and that statements and recommendations do not necessarily represent those of participants' institutions or agencies.

The information contained in this document is accurate as of 17 May 2005. The mitigation plan used during discussions and deliberations of PERG, described in Section 6.0, reflects the preliminary plan proposed by the Corps. That plan may have changed since this report was drafted. Furthermore, anticipated impacts resulting from construction of navigation improvements at Port Everglades may now differ from those presented in Section 4.0. Finally, additional field investigations detailing resources associated with reefs within, adjacent to, and offshore of the existing entrance channel have been carried out recently, and some of the information presented in Section 3.0 may now be out-dated.

Since suspension of formal PERG activities, several members have engaged in further natural resource investigations within and adjacent to the project area, corresponded and met with the Corps, and advised the Corps regarding offshore resources, construction plans, and mitigation issues. Though several years have passed since the Study was initially authorized, the Corps intends to continue to work with regulatory and natural resource agencies and incorporate findings from PERG as practicable in order to pursue project goals on behalf of the local sponsor and stakeholders.

Jason Evert, PERG Facilitator
Dial Cordy and Associates Inc.
17 October 2006

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1.0 INTRODUCTION

Port Everglades (Broward County, Florida) is one of South Florida's strongest economic engines, with annual operating revenues of more than $112.5 million and total waterborne commerce exceeding 22 million tons in liquid, break bulk, and containerized cargoes. More than 6,400 ships call at Port Everglades (the "Port") in a year forming the basis of a diverse maritime operation that includes: a thriving cruise industry and a reputation as the "world's premier cruise port;" a growing containerized cargo business that establishes Port Everglades among the nation's top seaports; a major petroleum storage and distribution hub; South Florida's primary bulk cargo depot; and a favorite U.S. Navy liberty port.

Construction for Port Everglades was initiated in 1925, and the Port was officially established as a deepwater harbor in 1927 by the state legislature and dedicated in 1928. Although the federal project (waterways within the port constructed and maintained by the federal government) was completed in 1984, the most recent modifications to the Port were carried out between 1984 and 1991. Modifications during that period included deepening and widening of the Southport Access Channel, construction of a bulkhead, and creation of the Turning Notch (USACE 1990). The Dania Cutoff Canal, which flows into the Southport Access Channel, serves local drainage needs and lends access to Port Denison from the Intracoastal Waterway. In 1985-1986, the Port dredged that canal to –16' MLW +1 overdredge.

In May 1996, the Port Everglades Feasibility Study was authorized by a U.S. House of Representatives resolution. Congress added funding in the appropriations for fiscal year (FY) 1997 to begin the Feasibility Study, which investigates alternatives for the expansion and deepening of the Port and associated channels. The U.S. Army Corps of Engineers ("Corps") and Broward County, the local sponsor, entered into a cost sharing agreement on April 17, 1997. On June 29, 1999 the Port requested that the Corps re-scope the Feasibility Study in order to address future calls of larger container vessels than original plans forecasted. In addition, the Port recognized that larger (i.e., wider beam) cruise vessels at berth would impact transiting of larger container vessels to Southport. Therefore, the Port suggested that the Corps not only take into account the Southport Access Channel (SAC), but also the entire waterway system within the Port. The Study Agreement was amended April 4, 2000, February 2, 2001, March 25, 2002, and May 19, 2003, June 5, 2005, and January 10, 2006 (one additional is pending). Preliminary plans for construction of elements developed through the Study involve impacts to approximately 25 acres of previously- and not-previously-impacted reef and hardground habitats (see Section 3 for details). Further details regarding the project will be available in the *Draft Environmental Impact Statement, Navigation Improvements, Port Everglades Harbor*.

The purpose of the Port Everglades Reef Group (PERG) was to provide guidance and expert advice on the most scientifically, technically, and logistically sound methods to provide mitigation for impacts to reefs and hardgrounds due to proposed navigation improvements at Port Everglades. Consultants contracted by the Jacksonville District of the Corps coordinated PERG. Details regarding the framework in which PERG operated are found in the following section, and its findings are presented in Sections 7 and 8, following several sections describing the project setting and affected natural resources, anticipated project impacts, preliminary mitigation plans, and mitigation requirements of regulatory and natural resource agencies.

2.0 PORT EVERGLADES REEF GROUP

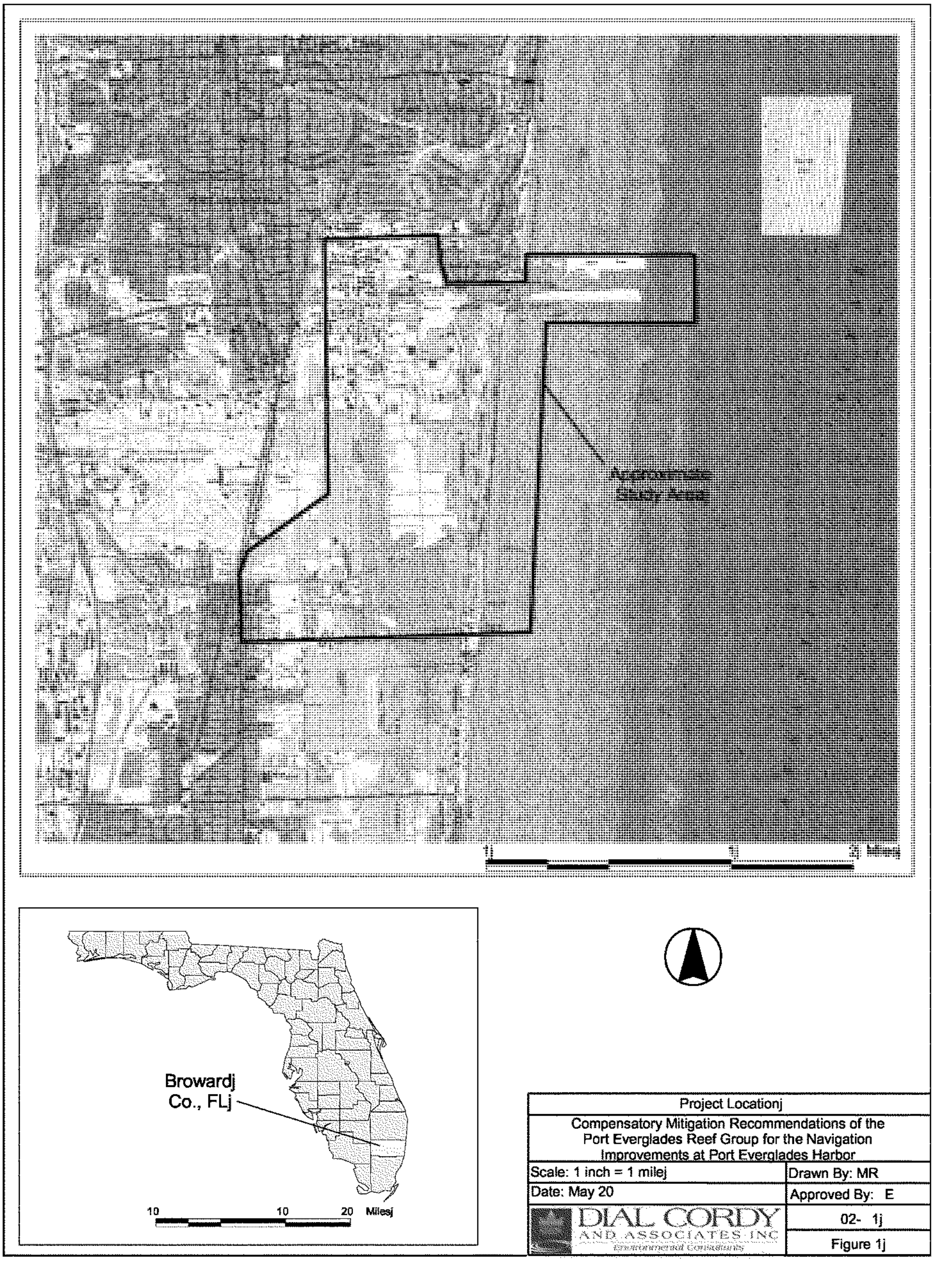
The Port Everglades Reef Group (PERG) was formed under direction of the Jacksonville District of the Corps to solicit guidance and expert advice on the most scientifically, technically, and logistically sound methods to adequately provide mitigation for impacts to reefs and hardgrounds due to navigation improvements at Port Everglades. PERG was tasked with this objective in absence of a known budget and without knowledge of the timeline under which impacts and mitigation were to take place. Furthermore, members were provided the results of the preliminary Habitat Equivalency Analysis (HEA) assigning an approximate amount, or acreage, of reef creation that might be necessary as compensation for impacts. PERG was informed that funds for mitigation construction and related measures would be included in the federal budget along with costs for navigation improvements. In general, PERG members necessarily discussed mitigation measures within only a conceptual framework. For example, PERG members were presented with questions such as "if reef construction were to be carried out, what materials should be used, and where and how should materials be placed?" or "what other types of mitigation should be investigated that would provide ecological benefits similar to those provided by artificial reefs?" or "what ecological and biological considerations must the Corps be aware of when carrying out mitigation?"

PERG conducted four meetings at the Port Everglades administration building between May 2002 and April 2003 in Fort Lauderdale, one of which was in conjunction with a field visit to impact and potential mitigation sites. The membership comprised scientists, resource coordinators/managers, and regulatory staff representing a variety of agencies/institutions. Participant names, affiliations, and contact information are listed in Appendix A. Other individuals were invited to be part of the group, but declined. Notes from meetings are included in Appendix B. Those notes comprise paraphrased statements, indicating some of the issues that were discussed at the meeting. They are not, nor were they intended to be, direct or complete transcripts. During meetings and subsequent communications, mitigation options, methods, and techniques were recommended based on conceptual mitigation options. In some cases, needs for additional information that would be critical in the formulation of a comprehensive mitigation program were identified, and additional sources of information were indicated.

3.0 PROJECT SETTING

3.1 Environment

Port Everglades Harbor is the waterway servicing the seaport, which is situated on the southeastern coast of the Florida peninsula within the three cities of Fort Lauderdale, Hollywood, and Dania Beach, as well as unincorporated Broward County (Figure 1). It is approximately 23 miles north of Miami, 48 miles south of West Palm Beach, and 312 miles south of Jacksonville. Port Everglades' jurisdiction encompasses a total of 2,190 acres (887 hectares), which includes 1,742 acres of upland and 448 acres of submerged land.


Approximate
Study Area
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Project Locationj
Compensatory Mitigation Recommendations of the
Port Everglades Reef Group for the Navigation
Improvements at Port Everglades Harbor
Scale: 1 inch = 1 milej
Drawn By: MR
Date: May 20
Approved By: E
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Environmental Consultants
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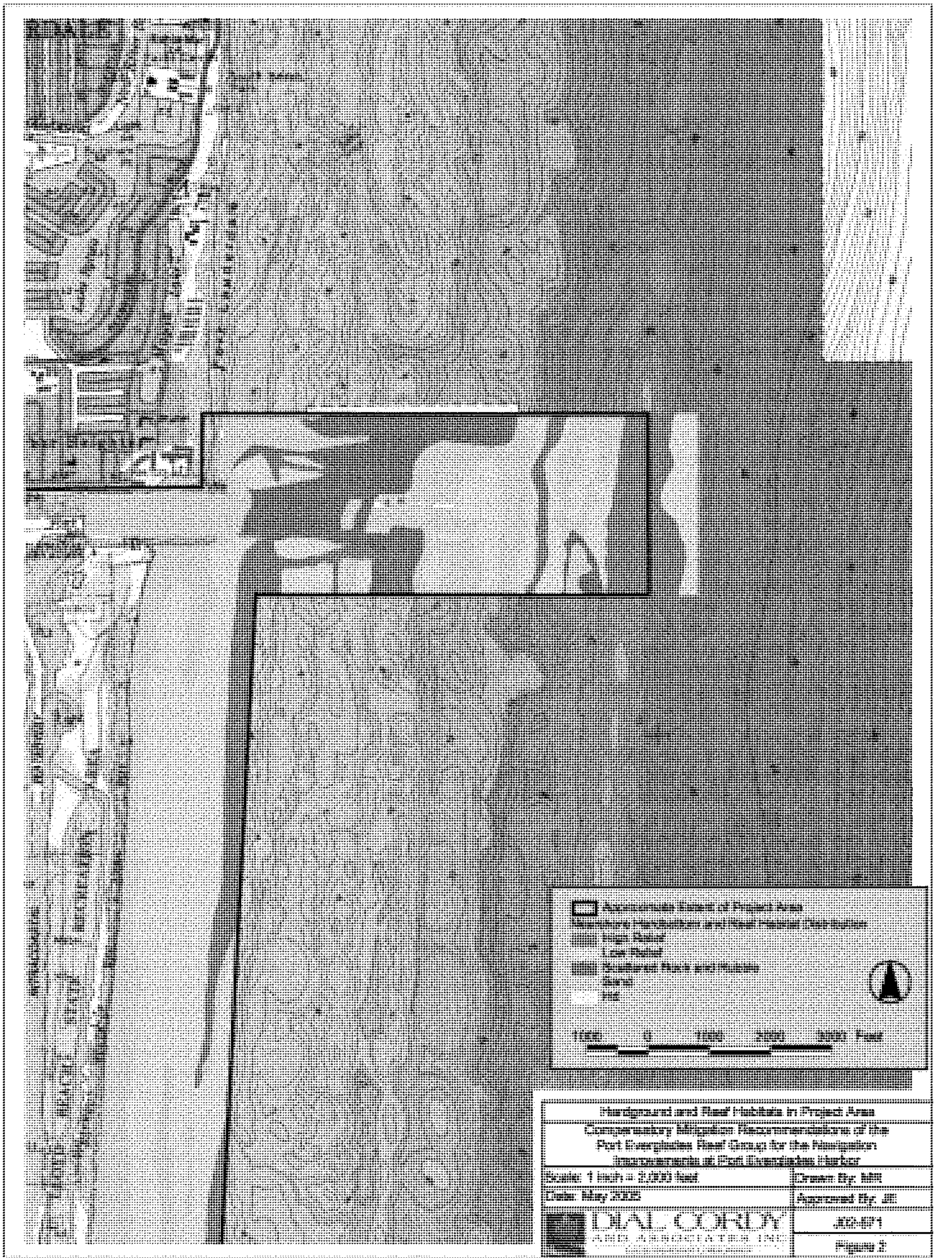
Figure 1j

3.2 Hardground and Reef Resources

The most prevalent hardground and reef zones within and adjacent to the project area fall within four areas: a nearshore hardbottom zone and three offshore reef tracts (see Figure 2). The nearshore hardbottom communities typically occur in 0 to 10 feet of water and exist in a physically stressed environment (high turbidity and sedimentation, wave action, etc.). Although sections of the zone may be covered with broken shell and sand, wave action frequently exposes the hard substrate. Some nearshore hardbottom areas east of John U. Lloyd State Recreation Area (JULSRA) have been characterized by permanent belt transects. Depending on distance from shore, these relict shoreline deposits may support communities dominated by algae and sponges with interspersed gorgonians and hard corals.

Seaward of the nearshore, hardbottom area there are three separate parallel reef tracts. The first reef occurs from approximately 100 to 2,000 feet from shore; the second reef is 3,000 to 6,000 feet offshore; and the third reef is approximately 8,000 feet or more offshore (USACE 1996). There is an extensive sand area located between the second and third reef lines (USACE 1996). The area between the first and second reef lines is characterized by small isolated hardbottom patches and interspersed coral rubble interrupting areas of open sand. These reefs, particularly south of the Outer Entrance Channel (OEC), may be subject to pulses of decreased water quality (e.g., suspended sediments, turbidity, pollution, lowered salinity) due to urban and agricultural runoff that exits via the channel. These reefs are lower profile than the outermost reef and less biologically diverse. The outermost reef, in general, has a higher percent cover of coral, greater diversity, and greater coral biomass than other reef areas.

Limestone rock and rubble remaining from previous dredging events (1984-1991) provide hardgrounds with variable-depth profiles in the 42-foot deep Outer Entrance Channel. Since the previous dredging event, gorgonians, corals and sponges have colonized these substrates. These low- and high-relief reef areas are found among softbottom habitats, rock/rubble habitats, and patchy *Halophila decipiens* beds. In general, these rock-reefs are not as biologically diverse as reefs that have not been subjected to dredging outside the channel zone (DC&A 2001). However, where the channel-bed rock-reefs and channel walls lie adjacent to undredged offshore reef lines, biodiversity and colony density increase. Channel-wall habitats have less coral coverage than channel-bed habitats, but provide significant refugia for reef-associated fishes. Even channel wall habitats not associated with reef lines are significant resources. These may be considered "vertical hardgrounds." Seaward from the confluence of the Inner Entrance Channel with the Intracoastal Waterway, biotic cover of channel bed and wall substrates increase, and undergo a progression from scattered algae and sponges to a mixture of live-bottom species including gorgonians and typical encrusting marine fauna (DC&A 2001). Extensive biotic cover of channel-wall substrates occurs from the jetty to the end of the Outer Entrance Channel. This pattern is more pronounced on the north side, as fish species richness and population density increase.


Approximate Extent of Project Area
High Relief
Low Relief
Scattered Rock and Rubble
Sand
1000 0 1000 2000 3000 Feet
Hardground and Reef Habitats in Project Area
Compensatory Mitigation Recommendations of the Port Everglades Reef Group for the Navigation Improvements at Port Everglades Harbor
Scale: 1 inch = 2,000 feet
DIAL CORDY AND ASSOCIATES INC
Figure 2

3.3 Biological Communities

Live hardbottom and reef communities of Florida's southeast coast have been characterized (Dodge et al. 1991; and others) and are considerably speciose. Species composition of the nearshore hardground and the three offshore reef tracts is related to depth, distance to shore, exposure to waves and currents, light penetration, and disturbance/dredging regime.

Nearshore Hardbottom. The nearshore hardbottom habitat is very dynamic and populations of associated species are able to quickly recover from the stresses imposed by the environmental conditions. Dominant algae associated with these communities include *Caulerpa* sp., *Jania* sp., *Laurencia* sp., *Dictyota* sp., and *Halimeda* sp. (Dodge et al. 1991; Vare 1991). Also associated with the nearshore hardbottom are the algal-mat species Cladophora, *Chaetomorpha*, and *Gelidiopsis* (USACE 2000). The rock outcrops in this area tend to be covered with sponges of the genera *Ircinia* sp., *Niphates* sp., *Cliona* sp., and *Iotrochota* sp. Interspersed among these sponges are colonial anemones (*Zoanthus* sp.), and hydrocorals (*Millepora alcicornis*). This habitat often provides suitable habitat for a variety of other invertebrate species (USACE 2000).

Nearshore hardbottom fish assemblages are characterized by diverse, tropical faunas that are dominated by early life stages. Over 190 species within 62 families have been recorded in association with nearshore hardbottom habitats of mainland southeast Florida. At least 90 species are utilized in recreational, commercial, bait, or aquaria fisheries. Additional ecologically important species that utilize the nearshore hardbottom reefs at some point during their lifecycle include jacks, Florida pompano, tarpon, grunts, and drums. Lindeman and Snyder (1999) concluded that at least 35 species utilize nearshore hardbottom as a primary or secondary nursery area. At least ten of these species are managed under the South Atlantic Fisheries Management Council *Snapper/Grouper Fishery Management Plan*. Detailed information on the snapper/grouper complex (containing ten families and 73 species) and other federally managed fisheries and their Essential Fish Habitat (EFH) is provided in the 1998 amendment of the Fishery Management Plans for the South Atlantic region prepared by the South Atlantic Fisheries Management Council (SAFMC). The 1998 generic amendment was prepared in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (P.L. 104-297).

Hardgrounds Within Channel Zone. This area of low-relief hardbottom is rock exposed from prior dredging events and supports many quickly colonizing species such as sponges (e.g. *Ircinia* sp., *Niphates* sp., *Cliona* sp., and *Iotrochota* sp.) and gorgonians (e.g. *Eunicea* sp., *Plexaura* sp. and *Pseudopterogorgia* sp). Species diversity and colony densities are lower within the channel than they are in reefs adjacent to the channel that have not been dredged. Channel walls, like the channel bed, that were created as the entrance channel was dredged, now provide substantial habitats for many species, particularly fishes (see below).

Adjacent Reefs/Hardgrounds. The three distinct reef tracts offshore of Broward County are consistent with the overall assemblage of stony corals, sponges, and gorgonians found throughout Dade, Broward, and Palm Beach Counties (USACE 2000). The most dominant feature of the reef communities near Port Everglades is the high density of gorgonians. These gorgonian corals are primarily of the genus *Eunicea* sp., *Plexaura* sp., and *Pseudopterogorgia* sp. Hard coral species also make up a significant part of the reef assemblages in this area and include *Porites asteroides, Diploria clivosa, Siderastrea siderea,* and *Montastrea cavernosa* (Dodge et al. 1991; Vare 1991; M. Johnson, pers com). The most diverse of the adjacent reefs is the outermost reef tract. Also, that reef has the highest density of colonies.

4.0 SUMMARY OF PROPOSED IMPACTS

4.1 Direct Impacts Inside the Existing Channel

Direct impacts to hardbottom and reef communities will occur as a result of proposed dredging to deepen and widen the Outer Entrance Channel (Figure 3). There will be 9.14 acres of impact to low-relief hardgrounds within the existing channel. Sessile invertebrates and hard substrates, such as boulders, outcrops, limerock shelves, and exposed hardbottom form the backbone of a diverse, and economically and ecologically important ecosystem. Impacts to habitats within the existing channel are significant even though they are not as speciose as habitats outside the existing channel. Although these live-bottom habitats have been dredged in the past, their value to fish and wildlife is considerable. Assemblages of sessile organisms in previously dredged areas may recover and reach the functional value of hardground habitats currently found in the channel in approximately 10-15 years.

4.2 Direct Impacts Outside the Existing Channel

Approximately 16.57 acres of previously undredged reef habitat will be impacted by widening and extending the Outer Entrance Channel (Figure 3). New impacts outside the existing channel will include dredging 5.75 acres of low-relief reef and 10.82 acres of high-relief reef. The coral reef forming the outermost tract is one of the most important coral reef resources in southeast Florida. Its distance from shore and the harbor possibly results in less disturbance and subsequently improved ecological condition in comparison to the other two reef tracts. Impact to the reef habitat at the end of the OEC would result in direct removal of many corals and gorgonians. These organisms dominate the community and are important for many fish and other invertebrate species. Impacts to this reef habitat will decrease the offshore ecosystem's carrying capacity for many reef-dependent invertebrate and vertebrate species, including managed species. Therefore, loss of coral reef habitat will likely result in changes at the population level for many species, and possibly an overall change in fish community structure in the immediate vicinity, due to alterations in physical habitat characteristics. Individual coral colonies, which may have taken hundreds of years to form, will be lost unless relocated.

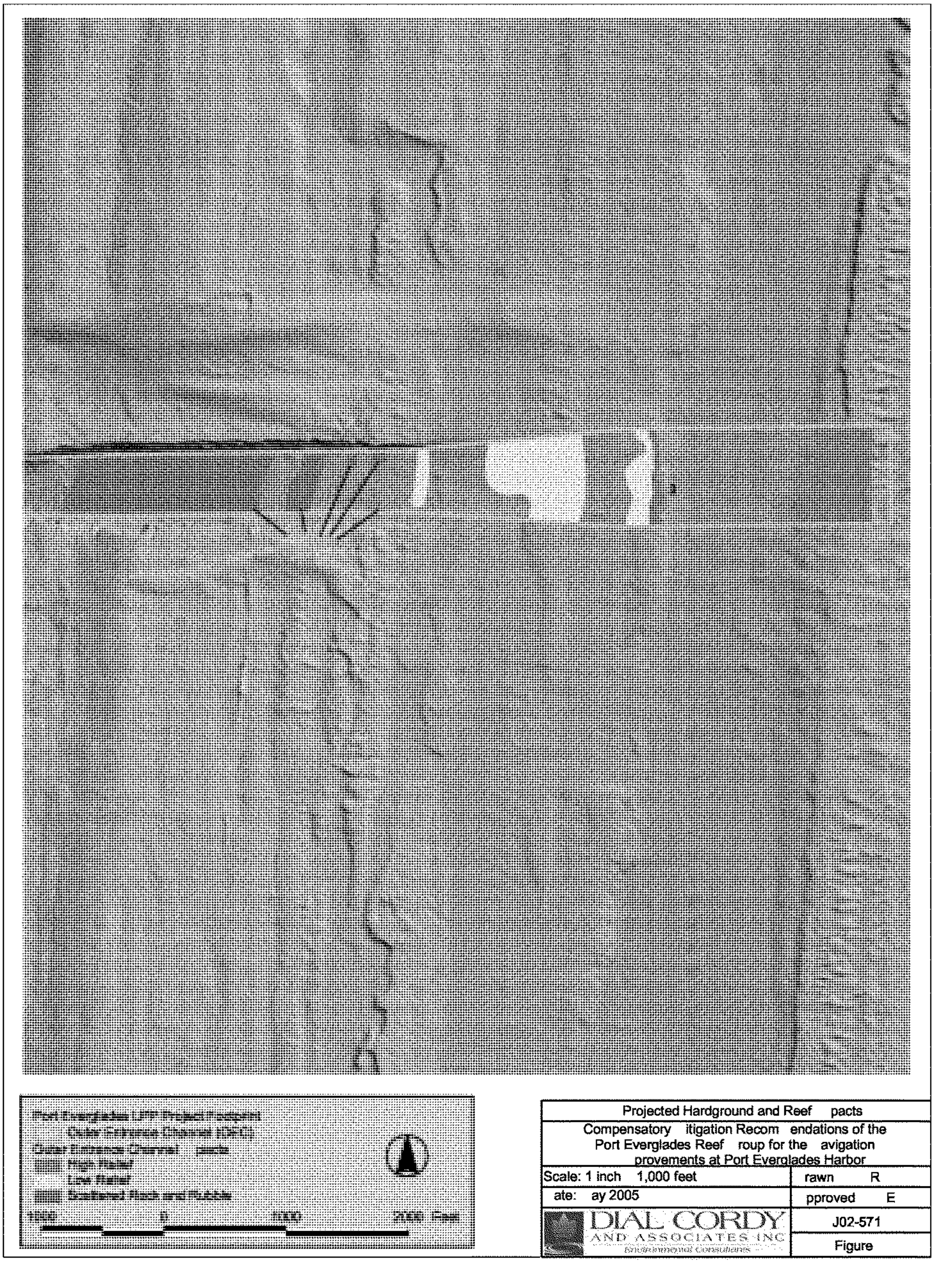

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Figure

4.3 Indirect Impacts

Indirect impacts of dredging hardbottom and reef habitat may include temporary changes in adjacent habitats. In particular, reef and hardbottom habitats just outside the new entrance channel may be affected. Potential indirect impacts may include the re-suspension and deposition of sediments on nearby coral reef assemblages. This re-suspension of sediments may also result in periods of increased turbidity within the area. The effects of this turbidity may include a temporary reduction of photosynthetic activity on the reef, as well as sublethal effects to coral colonies. Although biological indicators of coral stress may be evidenced for a short period of time, other effects, such as bleaching, excessive mucous production, tissue swelling, pathology, and adverse effects on reproduction resulting from shock may have long-term consequences. In addition, the period of physiological stress to corals can exceed that of the environmental disturbance. Other indirect effects include the displacement of fishes and invertebrates during dredge operations. These effects may be short-term.

5.0 MITIGATION GUIDELINES AND POLICIES

5.1 U.S. Army Corps of Engineers

Damage to fish and wildlife resources must be prevented to the extent practicable through thorough planning and prudent design that incorporate the mitigation principles defined within the Council on Environmental Quality's (CEQ) NEPA guidelines. Impact avoidance is of primary importance, followed by impact minimization, and, finally, compensation for unavoidable damages to significant fish and wildlife resources. The U.S. Army Corps of Engineer's Regulatory Guidance Letter 02-2 reinforces that compensatory mitigation is the last step in the sequencing requirements of the Clean Water Act §404(b)(1) guidelines. Measures to offset unavoidable damages to significant fish and wildlife resources will be included in projects when the cost of these measures are justified by the combined monetary and non-monetary benefits attributable to the proposed measures. These mitigation plans are to contain the most efficient and least costly measures appropriate to compensate for fish and wildlife resource losses. Mitigation of losses will be provided to the maximum extent practicable through the development and implementation of mitigation measures on-site. If on-site areas cannot support mitigation requirements, then separable public lands (or waters) adjacent to the project, to the extent possible, are given consideration. Acquisition of an interest in any lands or waters for mitigation of damages to fish and wildlife resources that do not comply with the limited authority provided by Subsection 906(b) of WRDA 1986 requires specific congressional authorization (See paragraph 19-8a(2)). Measures to mitigate project-caused damages to significant fish and wildlife resources are "project costs" and will be allocated to the responsible (causative) purposes of the project in the same way as other project costs. Mitigation costs will also be shared to the same extent as the other costs allocated to such purposes are shared. The mitigation costs include separable first costs (any lands and construction) and separable operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs (USACE 1999).

5.2 U.S. Fish and Wildlife Service

In developing the U.S. Fish and Wildlife Service (USFWS) Mitigation Policy (*Federal Register* 46 (15), Pg. 7656), the definition of mitigation contained in the Council on Environmental Quality's National Environmental Policy Act regulations (40 CFR 1508.20[a-e]) was used. As such, mitigation can include:

1. avoiding the impact all together by not taking a certain action or parts of an action;
2. minimizing impacts by limiting the degree of magnitude of the action and its implementation;
3. rectifying the impacts by repairing, rehabilitating, or restoring the affected environment;
4. reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
5. compensating for the impact by replacing or providing substitute resources or environments.

This definition recognizes mitigation as a step-wise process that incorporates both careful project planning and compensation for unavoidable losses and represents the desirable sequence of steps in the mitigation planning process. Initially, project planning should attempt to ensure that adverse effects to fish and wildlife resources are avoided or minimized as much as possible. In many cases, however, the prospect of unavoidable adverse effects will remain in spite of the best planning efforts. In those instances, compensation for unavoidable adverse effects is the last step to be considered and should be used only after the other steps have been exhausted.

The Service's Mitigation Policy focuses on the mitigation of fish and wildlife habitat values, and it recognizes that not all habitats are equal. Thus, four resource categories, denoting habitat type of varying importance from a fish and wildlife resource perspective, are used to ensure that the mitigation planning goal will be consistent with the importance of the fish and wildlife resources involved. These categories are based on the habitat's value for the fish and wildlife species in the project area (evaluation species) and the habitat's scarcity on a national, regional, or local basis. Resource Category 1 is of the highest value and Resource Category 4, the lowest. Mitigation goals are established for habitats in each resource category.

The mitigation goal for Resource Category 1 habitats is no loss of habitat value since these unique areas cannot be replaced. The goal for Resource Category 2 habitats is no net loss of in-kind habitat value. Thus, a habitat in this category can be replaced only by the same type of habitat (i.e., in-kind mitigation). The mitigation goal for Resource Category 3 habitats is no net loss of overall habitat value. In-kind replacement of these habitats is preferred, but limited substitution of different types of habitat (out-of-kind mitigation) perceived to be of equal or greater value to replace the lost habitat value may be acceptable. The mitigation goal for Resource Category 4 habitats (considered being of marginal value) is to minimize loss of habitat value (section supplied by B. Rieck, USFWS).

5.3 National Marine Fisheries Service

As described in the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), the Essential Fish Habitat (EFH) provisions of the act support the objective of maintaining sustainable fisheries. Mitigation would be required for impacts to seagrass, reef/hardbottom habitats, and mangroves. NOAA Fisheries does not have an official mitigation policy and, therefore, evaluates projects and the associated sequential mitigation requirements on a case-by-case basis. Mitigation may not be required for dredging softbottom habitats lacking seagrasses.

The focus of the sequential mitigation policy is to conserve and enhance EFH and to avoid, minimize, and compensate for impacts to EFH due to development activities. Like other federal agencies with regulatory responsibilities, the first priority of the National Marine Fisheries Service (NMFS) is natural resource impact avoidance when presented with any proposed project. When unavoidable impacts to EFH are proposed, NMFS will recommend measures to minimize unavoidable impacts. Finally, NOAA Fisheries may recommend mitigative measures to compensate for any loss of resource value, including loss of functional value from indirect impacts or temporal loss of habitat availability. Recommendations may include restoration of riparian and shallow coastal areas (i.e., reestablishment of vegetation, restoration of hardbottom characteristics, removal of unsuitable material, and replacement of suitable substrate), upland habitat restoration, water quality improvement or protection, watershed planning, and habitat creation. Compensatory mitigation may be provided in the form of enhancement of existing habitat, habitat restoration, and/or creation of new habitat.

5.4 The State of Florida

The Florida Department of Environmental Protection (DEP) and the Florida Fish and Wildlife Conservation Commission (FWC) share responsibility for preserving and protecting reef and hardground habitat in state waters. Reef and hardground mitigation serves the stated strategic goal for the Marine and Estuarine Conservation component of the Marine Resources Program of DEP, which is to "preserve, enhance, and restore the desired natural functions of Florida's marine and estuarine ecosystems and the diversity fish and wildlife populations." (*People, Progress, and the Environment, Agency Strategic Plan for FY 1998-2003*, V. Wetherell, DEP. 94 pp.). Indicators of progress include the "restoration of critical marine and estuarine habitats," and an "increase in abundance of priority marine and estuarine plant and animal species ..." To determine adequate mitigation for impacts within surface waters and wetlands in the State of Florida, the Uniform Mitigation Assessment Method (UMAM) has been implemented (F.S. 62-345). UMAM is used to estimate and compare ecological function in impact areas and mitigation areas. To-date, no UMAM has been performed in reef impact areas or respective mitigation areas.

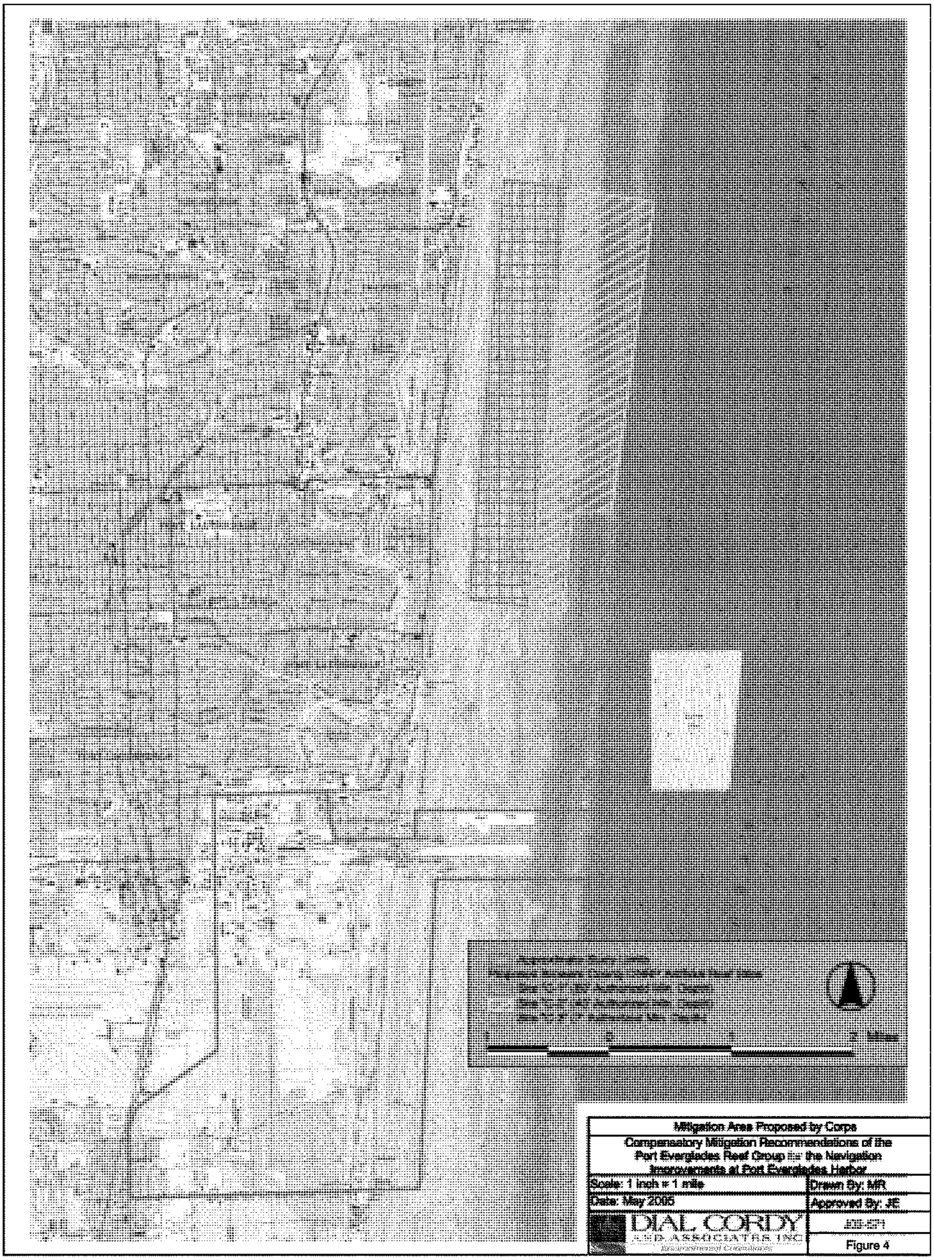
With guidance from the United States Coral Reef Task Force, the Florida Department of Environmental Protection, and the Florida Fish and Wildlife Conservation Commission have coordinated formation of an interagency Southeast Florida Action Strategy Team (SEFAST) for coral reef conservation and management. This team has completed a Local Action Plan in December 2004 to improve coordination of technical and financial support for the conservation and management of the coral reefs from the southern Miami-Dade County line to Hobe Sound (Martin County). A copy is available on-line at www.dep.state.fl.us/coastal/programs/coral/.

5.5 Broward County

The mission of the Biological Resource Division of the Broward County Environmental Protection Department (EPD) is to protect, restore, and enhance the biological productivity, abundance, and diversity of marine, estuarine, freshwater, and terrestrial resources. This is accomplished through dredge and fill regulation, mitigation, a tree preservation ordinance, beach restoration, coral and artificial reef management, and beach erosion studies. The Marine Resources Section of EPD, in executing its charge to protect, restore, and enhance the County's marine resources, is committed to the highest standards of technical and scientific integrity and to conducting its activities in the safest and most efficient manner possible. The Section's duties are project-oriented, rather than regulatory, and can be divided into two general subject areas: coastal engineering/beach erosion control, and marine biological projects/studies.

6.0 PRELIMINARY CORPS-PROPOSED MITIGATION PLAN

The Corps and local sponsor intend to compensate ecological functions lost due to direct impacts to reef and hardbottom habitats from construction of the proposed project (see DC&A 2004b). Direct impacts would be mitigated for by the creation of artificial reef habitat at a 2:1 ratio (mitigation acres: impact acres) for high-relief reef habitat, 1.3:1 ratio for low-relief reef habitat. Mitigation values were determined using HEA, which take into account recovery times of mitigation and impacted areas as well as the acreage of direct impacts. Mitigation reefs would be constructed in two different designs and to reflect the differences in the habitat structure of the two types of reef/hardbottom habitat to be impacted. A total of 7.54 acres of Low Complexity-Low Relief (LCLR) hardgrounds would be created to mitigate for impacts to not-previously-dredged, low-relief hardgrounds and previously impacted (i.e., existing channel-bottom) hardbottom habitat. A total of 21.33 acres of High Complexity-High Relief (HCHR) reef would be created to mitigate for the high-relief impact. The proposed locations for mitigation reefs are previously permitted, Broward County artificial reef sites (Figure 4). HRHC relief will range in profile from 3 to 6 feet, whereas LRLC will range from 1 to 2 feet. Limestone rock excavated from the Outer Entrance Channel, Inner Entrance Channel, Main Turning Basin, and South Turning Basin, and, if necessary, supplemental, quarried limestone will be used in reef construction. The HRHC reefs are intended to mitigate for impacts to high-relief habitat and the LRLC reefs are intended to mitigate for impacts to lower relief reef and for temporal impacts to hardbottom habitat previously impacted by channel dredging (DC&A 2004b).


Mitigation Area Proposed by Corps
Compensatory Mitigation Recommendations of the
Port Everglades Reef Group for the Navigation
Improvements at Port Everglades Harbor
Scale: 1 inch = 1 mile
Drawn By: MR
Date: May 2005
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC
Environmental Consultants
Figure 4

Artificial reefs constructed for mitigation must be monitored to ensure viability and adequate compensatory value. The monitoring program for the mitigation reefs will consist of both physical and biological components. Physical monitoring will assess the degree of settling of the reef materials, and biological monitoring will assess populations of algae, invertebrates, and fishes, as compared with concurrent control sampling of natural reefs. Monitoring will be conducted annually in the summer months. In order to supplement quantitative monitoring efforts and provide a permanent record of reef conditions and biota, each sampling effort will include a video transect swim covering the entire area of the mitigation reefs.

The degree of settling and/or sand covering will be assessed by measuring the relief at each of the permanent quadrat stations established as outlined below. Measurements will be taken with a weighted flexible tape from a point one meter shoreward of the quadrat benchmark to the surface of the water and from the top of the reef structure at the benchmark to the surface of the water, with the difference being the relief. The mean of five such measurements will be used to assess the degree of settling and/or sand covering of the materials. Changes in relief at the control reef quadrat benchmarks will be assessed by the same method.

Five randomly selected locations on each type of mitigation reef will be used as photoquadrat stations to assess sessile invertebrate and algae abundance. Randomly selected stations on high- and low-relief natural hardbottom reefs will also be established to serve as controls. Locations for ½-square-meter photoquadrats will be marked using steel pins and DGPS. Invertebrate and algal abundance will be evaluated from digital photography of each quadrat. Species will be identified to the lowest practical taxon and ranked in order of abundance. Superimposing a grid over the digital image and counting bare and colonized grid squares will assess overall percent cover (Bohnsack 1979). Criteria for success of the mitigation reef will be based upon a comparison of a total percent cover of algae and invertebrates at the new reefs and at control reefs of corresponding relief type. The criteria for success of the mitigation reefs in establishing a similar community structure will be a finding of no significant difference in the rank abundance orders of species between mitigation and control reefs of each type. Statistical comparisons between mitigation and control reefs will be made using the Wilcoxon Rank-Sum (Zar 1984) or similar nonparametric test at p=0.05.

Fish population evaluations will be based on visual censuses conducted separately on HRHC and LRLC mitigation reefs and high and low relief control reefs. The point-count method (Bohnsack and Bannerot, 1986) will be used for fish assessment. This method has the advantage of gathering quantitative data in a relatively short time in a very repeatable pattern that is relatively insensitive to differences in habitat structure. Each census will have a duration of five minutes and a radius (the distance from the stationary observer) of 10 feet. Ten censuses will be collected on each of the four reef types. Data from these types of censuses is rarely normally distributed, so the Wilcoxon Rank-Sum or a similar nonparametric test will be used for significance testing. The criteria for mitigation reef success will be a finding of no significant difference at p=0.05 between reef type pairs (HRHC vs. high relief control and LRLC vs. low relief control).

Results of all mitigation-reef monitoring efforts will be summarized in an annual report to be completed by December 31 of each year the monitoring program is in place. Copies of the report will be distributed to all concerned agencies and interested parties.

7.0 FINDINGS OF PERG

7.1 Compensatory Mitigation Objectives

Discussions during PERG meetings focused on reviewing common mitigation practices and procedures, critiquing past mitigation efforts, and investigating several novel or unconventional mitigation measures that could be carried out while fulfilling the mitigation guidelines of federal, state, and local regulatory agencies. Because mitigation guidelines of various agencies are not identical, and due to the differing focal issues and interests for each agency, it was necessary first to determine how agencies interpreted mitigation guidelines and whether those guidelines allow for any flexibility to consider alternative mitigation measures and compensatory values.

Compensatory mitigation is usually an option only after impacts have been avoided and minimized to the maximum extent practicable. When mitigation becomes necessary, restoration and enhancement of habitats is generally preferred by regulatory agencies to new habitat creation. This may be because regulatory agencies have found that functional benefits of mitigation sites involving restoration or enhancement are usually reached more quickly, and with less risk of failure, than with sites involving new habitat creation.

When restoration and enhancement options are not available, compensation for lost ecosystem functions must be provided in other ways. The most common method of meeting this objective is through habitat creation. Agencies espouse the "like-for-like" mitigation paradigm, i.e., that compensatory mitigation must provide habitat like that which is impacted during a given action. Although like-for-like (LFL), or "in-kind," mitigation seems like a simple concept, is can be difficult to apply in a complex, 3-dimensional, marine environment. For example, where it may be feasible to provide one physical characteristic that is "like" the impacted resource, it may not be possible to provide another. Hence, no habitat replacement can be *exactly* LFL because the compensatory mitigation will take place in at least a slightly different location than where the impact occurs. By virtue of that fact alone, especially in a marine environment, compensation will provide slightly different services to the ecosystem and resident flora and fauna. One should note that there might be several ways to define LFL habitat as well, such as same depth, same distance to shore, same distance to cross or Gulf currents, same wave action, or same substrate. LFL could incorporate all of these, some of these, as many of these as possible, or a select number of these that achieve some ultimate goal. In summary, it seems that the definition and goals of LFL mitigation should be adaptive, compensating the ecosystem for lost ecological services, but retaining as many of the characteristics of the impacted system as possible.

The definition of LFL was discussed, and, in particular, whether the policy objective was in-kind *habitat* creation, or in-kind *species assemblage* creation. Which one of these is the focus could determine how mitigation is carried out. For example, as noted above, variables such as water depth and exposure to Gulf currents must be taken into consideration if an in-kind species assemblage, rather than habitat, is the ultimate objective. In essence, the goals of LFL compensatory mitigation for habitat may not necessarily result in LFL community or population replacement. During PERG discussions, a faculty member from Nova Southeastern University (NSU) asked, assuming that in-kind habitat replacement was the objective, whether LFL could be met by providing "like" depth, substrate, or assemblage. USFWS staff responded that depth was usually the operative parameter.

The practicality of repeated application of the LFL paradigm was addressed by PERG. It was noted that simply creating artificial reef after artificial reef for all coastal projects would result in an excess of reefs that may be either depth- or structurally appropriate for mitigation purposes, but would not necessarily provide many of the important ecological services provided by reefs that have been impacted.

7.2 Additional Baseline Studies and Success Criteria

For any type of compensatory mitigation, success is measured by determining how well mitigation measures replace ecosystem functions lost via impacts due to a given action (for which the mitigation is provided). Therefore, success criteria are defined as a specific set of ecological objectives, or functions that the mitigation must provide, and specific levels of performance for each objective/function. Before determining how well mitigation measures function and what the mitigation objectives are, a detailed assessment of the functions provided by the habitats that will be impacted should be carried out.

At a minimum, a *qualitative* assessment of likely impacts should be conducted at each impact site. Dial Cordy and Associates Inc. (DC&A) has conducted such investigations for the proposed navigation improvements at Port Everglades. However, PERG members stressed the importance of *quantitative* data that would be used to establish more precise levels of performance for mitigation success criteria.

Various methods/sources could be used to gain comprehensive information about impact sites. Information from additional underwater video transects or reconnaissance dives using SCUBA would provide a more fine-scale assessment of impact areas than that which currently exists, and would be useful to aid in planning the placement of transects and quadrats that would be used for quantitative studies. Investigations should focus on collection of data for fishes and invertebrates, including both corals and motile organisms. Of particular interest are stocks of managed species utilizing essential fish habitats (EFHs), such as snapper and grouper taxa, since specific guidelines for impacts to EFH must be observed. Fish data can be used to determine baseline conditions (functionality) among impact sites, which may provide guidance in designing mitigation sites.

In addition to obtaining data on impact sites, obtaining baseline information at each of the proposed mitigation sites is necessary to gauge the success of mitigation, particularly where habitat restoration or enhancement is planned. Data from the planned impact and mitigation sites should be compared to other known data sets to determine whether they resemble those from the wider reef ecosystem, and to detect changes in the overall reef system once impacts and mitigation occur (e.g., do mitigation sites act as "attractors? "). NSU faculty indicated that they have a great deal of fishery data (collected at ¼-mile intervals along the coast) available for such use.

Prior to relocation of hard or soft corals, assessments should be carried out. They should comprise *in situ* data collection to quantify the number, size, and species of corals (and other relevant fauna) within the impact zone. Such data will allow a more detailed understanding of the feasibility of relocation of numbers and sizes of colonies. Donor and recipient sites for coral translocation must be identified also, and these must also be assessed for suitability and current environmental characteristics prior to carrying out mitigation activities.

7.3 Reef Enhancement

Based on LADS (Laser Aerial Depth Sounding), there appears to be an area of extreme low profile substrates in the third reef line south of the proposed channel. The area appears to have been previously impacted, and therefore is a candidate site for reef enhancement or restoration ("restoration" if further investigations determine the area was previously impacted). Enhancement of the reef at this site may qualify for funding through a federal Section 1135 (Water Resources Development Act) program. This site and mitigation option should be further investigated via field reconnaissance.

7.4 Reef Restoration and Preservation: Tire Removal

Approximately 31 acres of Broward County hardgrounds associated with the second reef line and adjacent softbottom habitats are covered by used automotive tires that had been deployed in the early 1970s for use as artificial reefs. The tire bundles subsequently broke apart, and now litter offshore habitats (Figure 5). These tires, particularly during strong currents, tides, or storms, have, and will likely continue to, move over, brush against, and abraid the natural reef surfaces, and even damage existing coral colonies. They also cover softbottom habitats, creating environments inhospitable to natural sand-dwelling flora and fauna. Although there is some coral and sponge growth inside and on top of tires, NMFS indicated that it is an inferior substrate for colonies, and hardgrounds and softbottom habitats would provide more suitable substrates. Several parties have video footage of diver tire transects, including Broward County Biological Resources Division, Dr. Robin Sherman of NSU, and the Florida Fish and Wildlife Conservation Commission.

A more comprehensive tire-removal operation was thoroughly considered by PERG, and participants had an opportunity to visit sites where impacts were occurring. PERG participants agreed that restoring reefs and further protecting existing ones by removing tires would be a valid form of compensatory mitigation for impacts of the navigation project to the second reef line.

The success of such a project may rest on the method that is used for tire removal, as that would dictate costs and the compensatory effectiveness of the task. Broward County staff conducted video surveys in June 2003, to define the areal extent of the tire field and characterize the impacts at the proposed enhancement site. Video records were geo-referenced using a HYPACK hydrographic survey system to allow integration into Geographic Information System (GIS) software, and areas were prioritized for removal. Because the tire-field is so expansive and removing all tires may be cost-prohibitive, it is unlikely that the entire lot would be removed at once. DEP suggested that tire-removal measures start at the southern

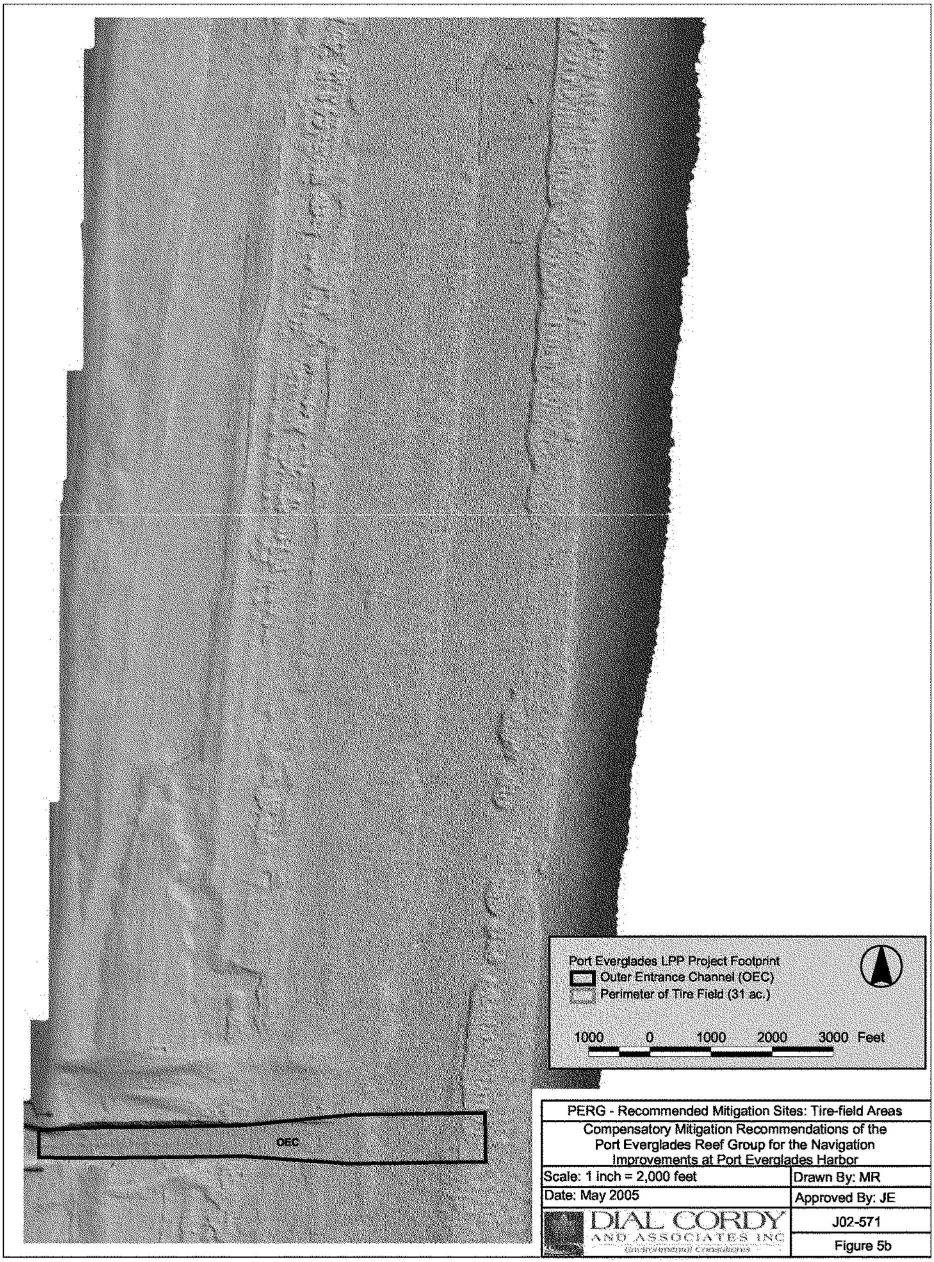

OEC
Port Everglades LPP Project Footprint
Outer Entrance Channel (OEC)
Perimeter of Tire Field (31 ac.)
1000 0 1000 2000 3000 Feet
PERG - Recommended Mitigation Sites: Tire-field Areas
Compensatory Mitigation Recommendations of the Port Everglades Reef Group for the Navigation Improvements at Port Everglades Harbor
Scale: 1 inch = 2,000 feet
Drawn By: MR
Date: May 2005
Approved By: JE
DIAL CORDY AND ASSOCIATES INC
Environmental Consultants
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Figure 5b

extent of the tire field, because otherwise the prevailing currents moving south to north may push tires into already cleared areas. Following a previous removal of approximately 1,600 tires (August 2001), newly exposed substrates were covered again by tires due to ocean currents. Another consideration for determining which tires should be removed is whether certain tires are closer to, or currently impacting, very sensitive habitats. Such "priority" areas have not yet been determined, but reconnaissance diving and underwater videography could aid in that effort. Depending on how tire removal is conducted, there may be secondary impacts to reefs. Therefore, more environmentally sensitive methods should be used within the reef habitats (than in softbottom habitats), such as diver removal of tires, or diver-mediated collection of tires (transfer to underwater bins/compartments which can be lifted). Hand removal of tires by divers in sensitive reef areas would prove to be much more expensive than bulk removal procedures, which could possibly be used over softbottom areas. In some cases, corals and sponges may be removed from tires and re-located to appropriate substrates. USFWS stated that any tire removal activities should be subject to monitoring to ensure that efforts are effective, and to demonstrate the utility of such a project.

There is additional appeal to include tire removal as part of the compensation package for navigation improvements. The project would be visible to the public, and could serve as a model program for environmental restoration. Since all tires cannot be removed simply through this mitigation program, non-governmental organizations (NGOs) and local sponsors could become involved, after having the Corps/Port provide somewhat of a "demonstration" program. NMFS voiced concern that any partial solution to the tire issue would be less favorable than a comprehensive plan. However, if the Corps/Port could take the lead in starting the restoration program, the momentum could result in comprehensive tire clean-up. The Port indicated that it should not be held accountable for the larger tire issue, even if it is willing to carry out compensatory measures by removing some sections of tires.

The costs for tire removal vary based on methods used, the spatial extent of removal, and the disposal of tires. Unconfirmed information from participants indicated that it would cost approximately $10 to remove one tire (not including land-based transportation and ultimate disposal of tires). If "number of tires removed" is used as the measure of compensation credit, and each tire is approximately five square feet in area, a theoretical "acre" of tires would comprise 8,712 tires. Therefore, it costs $87,120 per acre of tire removal, and $2,178,000 for 25 acres. For comparative purposes, it costs approximately $7,500,000 for placement of 25 acres of quarried limestone (for an artificial reef). Generally, it is likely that as more removal is conducted, cost per tire should decrease. Port staff noted that tipping fees would comprise a significant amount of the expenditures for tire removal activities. Therefore, it may prove useful to investigate alternative uses for tires (recycling, etc.). The Corps, Port, and local sponsors may benefit from applying for additional federal monies through Section 1135 and/or 206 programs to expand the tire-removal effort. The amounts and limits of such monies available should be determined. Additional funds may be available through other federal agencies (e.g., NOAA) or non-governmental organizations (e.g. National Fish and Wildlife Foundation). More accurate and detailed expense estimates should be sought for all components of the tire-removal program. If expenses are too high, a demonstration project could be initiated that would allow for the Port to provide adequate mitigation for impacts, but not be responsible for removal of all two-million tires from the second reef line and adjoining softbottom habitats.

Port staff indicated interest in investigating additional funding sources for tire-removal and in investigating the scope of the impact of tires to the second reef line. It was also suggested that a pilot program for tire removal should be conducted prior to any major operation in order to fine-tune a large-scale program.

7.5 Reef Habitat Creation

Where restoration and enhancement of reef resources are not available for use as mitigation, habitat creation has traditionally been offered as compensation for impacted habitats and lost ecosystem functions. Since new reef impacts would take place at water depths of approximately 40±2 feet (at first reef line where "flair" is planned), 52±2 feet (at second reef line), and 52±4 feet (at the third reef line) for the channel expansion at Port Everglades, it was suggested that these depths should influence the design of mitigation sites so that they achieve in-kind, LFL compensation. Though simply replicating depth might not replicate species assemblage, it is certainly one of the components that will need to be considered in order to supply proper compensation. Specific locations, reef design, and reef construction materials are other factors that must be considered, as they encourage recruitment by various assemblages. Mitigation should replicate the structural elements present at the impact site as closely as possible. For example, if investigations find that impacts to the third reef will involve removal of a flat, elevated plateau, then the replacement habitat should be built as flat, elevated plateau. In addition, the species assemblage present at the impact site should be examined so that the replacement habitat can be specifically engineered to create habitats conducive for recruitment of a similar assemblage.

7.5.1 Siting

Determining locations that would provide the appropriate depths was among the first matters discussed by PERG. Previously DEP-permitted Broward County artificial reef sites seemed to allow some opportunity for habitat creation. Navy staff confirmed that there are no Navy structures/cables in any of the permitted reef sites. However, Broward County staff indicated that most of the larger, depth-appropriate sites are already used, earmarked for use as mitigation, or reserved for research purposes. Large plots are currently available at only 25, 65, and over 75-foot depths. County staff noted that they retain maps of the permitted sites to 150'-deep. Generally, any sites shallower than 40' were excluded from further consideration as they may attract only juveniles and smaller fish, and thereby would not adequately replace the impacted assemblage.

Other possible locations at which reef habitats could be constructed include "reef-gaps." Reef-gaps are natural geologic formations where the profile of a reef line decreases appreciably, sometimes down to softbottom substrates. These reef-gaps can be readily seen on LADS plots. The geologic cause of these gaps is unknown. The gaps provide a nexus between deepwater offshore habitats outside the third reef line and the intra-reef area between the third and second reef lines, and, to a lesser extent, between the second and first reef lines. The gaps considered by

PERG were those in the third reef line, which could provide sites for LFL reef construction to compensate for impacts to the third reef line due to navigation improvements.

The utilization of third reef gap sites offers a unique opportunity that would not be available at mitigation sites found inside the third reef line. Because the gap sites are exposed to Gulf Stream currents, the physical conditions more closely replicate the situation at the third reef line impact site. Biological conditions at the reef-gap site are also more likely to recruit an LFL assemblage than more nearshore sites due to their position and physical environment. In other words, relative position of the mitigation site may be as important ecologically as depth.

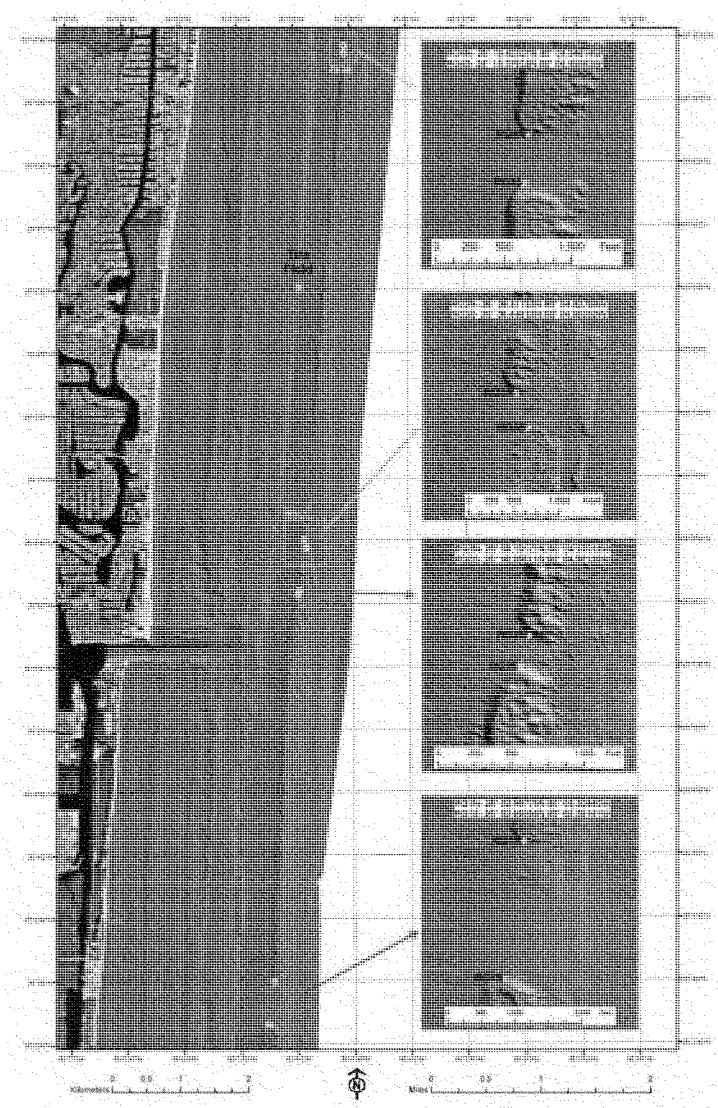
Several reef-gap sites were considered (Figure 6), although some sites may not be usable for one reason or another. DEP staff mentioned that a party has applied for a permit to install a pipeline through RG2 ("Reef-gap 2"). Also, utility/communications companies and the Navy may have equipment (e.g., fiber optics) buried in the sands at reef-gaps southeast of the proposed channel. The Navy should be contacted to determine if there are no structures/equipment running through the candidate reef gap sites. Some reef-gap sites may be too far from the impact area to effectively compensate for impacts of navigation improvements.

Other concerns regarding the placement of materials in reef-gap sites were raised. For example, analyses would have to be carried out to determine if reef materials and configurations would be hardy enough to endure swift, strong currents from the Gulf stream that enter the gaps. Also, care must also be taken during construction to avoid direct damage to existing reefs scattered within and adjacent to the reef-gaps. Finally, consideration would have to be given to whether habitat construction in these areas may have adverse environmental impacts on existing hardground and softbottom resources. Existing currents may have a significant physical and biological influence on habitats interior to the third reef line. Inhibiting or altering currents could have profound impacts on surrounding reef and softbottom habitats. It may be possible to mediate these possible effects by staggering constructed reef structures, limiting their profile, and/or moving reefs off from the central area of the reef-gap, i.e., toward the second reef line. This may be preferred anyway, because a staggered configuration more closely represents the natural reef characteristics near the gaps. Also, a more flat, elevated hardground plateau would more closely mimic the natural profile in this area. However, even if interruption of current to the intra-reef area did occur, these interruptions would be in effect "mitigated for" at the navigational channel impact site, where a new "reef-gap" will be created.

In case there is an excess of rock requiring disposal from the navigation project (i.e., over 50 acres), NSU faculty suggested some deep reefs (below 200 feet deep, or at 400+ feet) should be built. They noted that siting and monitoring could be achieved through use of ROVs.

7.5.2 Materials and Design

The use of habitat replacement materials must be carefully considered for logistical purposes, cost, and desired outcome. Materials should be selected following consideration of findings from baseline surveys at the impact sites and subsequent determination of success criteria. NSU retains some information on the effectiveness and uses of certain materials, and FWC noted that long-term (11-year) data for recruitment of constructed reefs at Sunny Isle are now available for



PERG - Recommended Mitigation Sites: Reef-gap Areas	
Compensatory Mitigation Recommendations of the Port Everglades Reef Group for the Navigation Improvements at Port Everglades Harbor	
Scale: as shown	Drawn By: MR
Date: May 2005	Approved By: JE
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	Figure 5a

examination. FWC also mentioned a document regarding artificial reefs permitted by the Corps that should be consulted. Finally, Broward County artificial reef sites should also be examined to determine if the assemblages recruited on those reefs would be considered LFL for the proposed project's impacts.

There was general consensus among PERG members regarding which material should be used for habitat construction. NSU faculty and DEP staff agreed that natural limerock should be used in some way at habitat construction sites, and Broward County staff referred to limestone as the "best" substrate. NMFS staff (M. Johnson) indicated that colonization was not as prolific on concrete as on limestone, but NSU faculty stated that concrete might last longer. Another option is a coquina-based concrete with crushed limestone veneer. It increases stability due to the use of concrete. DEP staff noted that FMRI recommends marl boulders.

Limestone should be available from blasting operations in the harbor's basins and certain parts of the navigational channels, such as the Southport Access Channel, but according to NSU faculty, it is not likely that any rock will be recovered from new dredging at the third reef line due to the underlying geology. Dredging and/or blasting methods and procedures will determine the type and size of rock that will be available for habitat construction. Use of quarried limestone boulders is another option, albeit more expensive ($300,000/acre) not including placement). Use of rock/rubble from within the current channel should also be explored, as rock/rubble dumped offshore has provided usable LFL low-relief habitat for other projects.

Some PERG members displayed some concern for the strict classification of, and constructing reefs defined as, "high-relief" and "low-relief." Participants seemed to place emphasis more on reef construction materials and depth of placement to achieve biological goals, although NMFS and DEP noted its concern for LFL replacement. Port staff noted that if high relief yields better biological results than low relief, it would be better to use the rock from additional low relief and instead use it to increase the profile of constructed habitats.

Depth of placement may influence reef design, as stability becomes increasingly important with depth. For example, at 40 feet of water, a limerock diameter of more than 3 to 4 feet is required to maintain stability (K. Banks). At 20 to 25 feet, only 3 feet of profile is necessary (H. Hudson). In deeper water, where there are no small habitats to try to avoid, use of prefabricated reef modules is sometimes better logistically.

Following additional studies of the impact area and its resident biota, attempts should be made to imitate the structure of impacted areas. Effectively "re-creating" the impacted habitats would involve adjusting constructed reef profile, size, shape, and structural configuration. For example, if impacts to the third reef involve removal of a flat, elevated plateau, replacement habitat should be built as flat, elevated plateau. In addition, the species assemblage present at third reef line should be examined so that the replacement habitat can be specifically engineered to create habitats conducive for recruitment of a similar assemblage. Sinking of substrates, scouring around substrates, and partial submersion in sand by substrates should be expected, anticipated, and where applicable, compensated for, during construction.

7.5.3 Logistics

To increase the success of compensation through habitat creation, materials for both structure and biological recruitment ("seed" material or translocated corals) are necessary, and several challenges exist in order to bring these elements together. The Port is currently further investigating geotech data, and is attempting to discern if it is possible to stage work west to east in the Main Turning Basin and entrance channel, working in the Southport Access Channel last. This would allow for some rock to be exported to mitigation sites in advance of dredging in the eastern portions of the project, thereby supplying a destination for corals translocated from the Outer Entrance Channel before it itself is dredged. Rock material for artificial reef construction will most likely be collected from rock-blasting operations in the Southport Access Channel and Main Turning Basin. Overlying rock/rubble will have to be pulled up prior to blasting. If neither dredged nor blasted rock is available for advance placement (at mitigation sites) to receive relocated corals (see Section 7.6), pre-fabricated modules could be installed at habitat creation sites as relocation substrate so that no colonies are lost during blasting/dredging. Just as with the relocation of corals, it may be desirable to transfer seed materials/colonies and parent rock/rubble to habitat replacement sites. Though mortality of colonies attached to rock may be high, some of the hardier biota may survive. Costs may be prohibitive. In conclusion, timing of work should allow for maximum relocation of corals from impact zone and use of native substrate materials. Blasting/dredging should not occur in offshore areas until colonies can be relocated from impact sites and transferred to enhancement and reef construction sites. If no mitigation areas are yet available to receive corals, some colonies from the inner channel and outer channel could be relocated to reef modules in previously permitted Broward County reef areas between the second and third reef lines.

7.5.4 Value-Added Habitat Creation

Since the size of reefs to be constructed is significantly large (approximately 20 acres of high-relief reef, in addition to 7.5 acres of low-relief reef, unless HEA is modified to include restoration/enhancement/coral relocation options), several PERG members suggested placing the reefs in such a way as to maximize their use as a platform for research. Reef modules/structures would be placed in lines, groups, or randomly, so as to produce replicates at various sites and at various depths. NSU faculty noted that eight replicate reefs (totaling 30 acres) would provide some statistical power for research purposes. The configuration and spacing of reefs is yet to be determined. Construction of reefs yielding some scientific usefulness may prove to be much more valuable to the future of reef conservation than simply constructing reefs in a simple or careless manner, and could be carried out in such a way as to not make the project significantly more expensive. Findings may help scientists and resource managers make better decisions regarding reef construction in the future based on findings from examination of reef dynamics, particularly those involving long-term datasets. To maximize use of these reef plots, baseline data should be taken at natural reference sites, and at the construction site immediately following construction. The Port expressed concern about spending additional resources on acquiring a reef design scheme that may benefit reef science, when it seemed that the first priority of PERG was to conduct mitigation (i.e., artificial reef creation) utilizing input from previous scientific work. Regardless of how such a project is designed, providing adequate mitigation for the navigation improvement project and achieving cost-efficiency should be the primary goal.

An ancillary goal of created reef sites could be placement and construction of artificial reef areas for research purposes. Providing (by regulatory agencies) additional mitigation credit for research-configured, created reef sites, because of their value in making future creation efforts more ecologically effective, was discussed.

7.6 Coral Relocation

NMFS typically advises that coral colony relocation constitutes a major part of avoidance and minimization criteria for impacts. The preferred manner to relocate is to use colonies from impact sites to create an initial assemblage at mitigation sites. In this way, the restoration site is more ecologically valuable as there is less temporal lag in the new community. Corals should be relocated by experienced personnel using established methods. Recently, for another project, approximately 600 colonies collected from 10 acres were relocated. The largest, and hence oldest, coral components of the site that was to be impacted were removed and transplanted.

Which restoration sites/construction sites should serve as recipient sites for translocated corals should be carefully considered. DEP noted that there may be a greater risk of losing corals due to impacts from drifting tires if placed at areas of the second reef line from which tires had been removed. This risk could be diminished if tires "upstream" (of current flow) from recipient sites were removed and no other tires posed a risk. Reef-gap sites and other constructed reef sites remain good candidates for receiving colonies. The colonies will have to be relocated to constructed habitats and restoration areas prior to dredging in outer channel/third reef, which will likely provide the greatest amount of raw biological material. Minimum size of colonies advisable for relocation is 12-15 cm (4¾"- 6") in diameter; NMFS recommends re-locating colonies over 6" (15 cm) in diameter. NSU staff indicated that this equates to corals approximately 15 years old. Dial Cordy staff questioned whether certain colonies should be given priority during the translocation process, i.e., those with the highest likelihood of survival, or rare species. NOAA staff questioned whether soft corals would be candidates for relocation. NMFS indicated that hard corals would be a higher priority because of longer recovery times. NOAA staff mentioned that it would be worthwhile to relocate older soft coral colonies; Broward County staff indicated that it was still possible to relocate them. DEP staff mentioned that those larger soft corals are more reproductively active and therefore more valuable. DEP also stressed the importance of relocating many colonies to one area rather then multiple sites, so that reproductive activity could be facilitated.

In order to minimize stress on colonies, maximize transplant survival, and thereby capitalize on assemblage function at the recipient sites, transplantation logistics need to be carefully planned and executed. NSU data indicate that coral transplant survival rate can be greater than 80 percent. Broward County staff noted that their survival rate was over 90 percent.

This activity should lower the overall mitigation area that was determined through use of HEA, because the severity of impacts will be lessened at the impact sites, and habitat creation sites will have a reduced recruitment interval.

Experienced marine biologists should be used to determine which corals should be relocated and to carry out the translocation. Transects should be conducted as per Section 7.2 to monitor growth following translocation.

7.7 Preservation: Water Quality Improvement

NSU and DEP staff suggested that improvements in water quality in the local area could help to preserve existing coral colonies. Locating and retrofitting broken or inadequate sewage outfalls could be a wise investment and appropriate use of dollars set aside for mitigation.

7.8 Compensation Credit

Initial Evaluation. HEA performed by the Corps indicated that 28.87 acres of artificial reef must be created to compensate for impacts that would occur to reefs and hardgrounds outside the current channel zone. If the proposed mitigation represents in-kind, LFL compensation, in order to reflect the ecological differences between the reef types impacted, approximately 21.33 acres would comprise HCHR, while approximately 7.54 acres of LCLR hardgrounds would be installed. These compensation acreages are for new habitat creation, and do not take into account any use of relocated corals (see Section 7.6 above) or deposition/installation of any biological material on constructed reefs.

Restoration and Enhancement. The issue of determining how the Corps/Port will receive compensation credit for partial tire-field clean-up has yet to be determined. There are several alternative methods of assigning credit that were discussed during PERG. One method could be to allow one-acre of tire clean-up on the second reef line to compensate for one acre of impact to the second reef line. However, the longevity of benefits provided by removing tires from the reef line only would likely be minimal without removing tires that are up-current form the restoration area. Those tires could drift back on to the cleared area, eliminating the benefits of removal. Possibly, two types of credit could be given, one type for tire removal on reefs, and another for removal over sand flats adjacent to reefs. Sand-flat removal of tires could be considered "preservation credit", and have slightly lower values than "restoration credits" on reefs. A sliding scale could also be used, i.e., credit per tire could be judged by distance to, and/or current impact on, hardground habitats. These credits would be applied to the HEA and Mitigation Bank Review Team (MBRT) calculations that were used to determine the number of acres of new habitat construction. Other methods of assigning credit to tire-removal include credit based on the depth of tires removed, and credit based on each tire, i.e., each tire occupies a fixed area (about 5 sf), and in sum, translates directly to a specific acreage of tires. NSU faculty noted that credit could also be applied to temporary impacts to the channel if biological assemblages currently in the channel were similar to those that occupy habitats adjacent to the second reef line north and south of the tire field.

Habitat Creation. DEP staff mentioned that the monitoring report for the Gulf Stream pipeline project includes several years of data and is now available for review. Information such as this could be used to more accurately predict recruitment intervals for constructed reefs. Re-location of corals to constructed habitats decreases HEA recovery-time values, and thereby can decrease the amount (acreage) of compensatory mitigation required. The "value" (credit) of re-location will depend on the number and size of colonies re-located. Just as with the translocation of corals (see Section 7.6 above), if seed materials/colonies and parent rock/rubble were removed and transferred to habitat replacement sites, HEA recovery intervals would decrease. It is thought that mortality for colonies still attached to rocks would be high, whereas those physically removed and cemented onto the new reef substrates would have survival rates between 80 and 90 percent. HEA should be revised to reflect recruitment interval changes. Also, if it is agreed that high-relief reef can be used in lieu of low-relief, HEA calculations would have to be revised.

Reef Research. Even if required acreage of reef creation decreases (from levels previously calculated via HEA) due to incorporation of restoration work and reduction of recruitment times on created reefs, there will still be enough to lend value to attempting to create replicate reefs for scientific research. Whether positioning reef units in a manner conducive to research, or whether keeping all materials in a continuous group (i.e., like at impact sites) should be further discussed. It is possible that since additional planning and labor may be necessary to plan/install reef replicates, regulatory agencies may choose to award some nominal mitigation credit for the future resource value (beneficial "indirect" future effects) that could be gained from such an investment. NMFS staff noted, however, that this might not be legally feasible because there is no statistical evidence that future resource value would be gained. The Port could decide to create "research arrays" of reefs on its own, but if additional costs are involved, regulatory agencies should consider whether issuing additional compensatory credit for such work has merit. Although USFWS expressed concern regarding assigning compensation credit for measures that were not considered "in-kind," NMFS also noted that LFL should be the rule, but indicated that some experimental work could impart on future reef work possible insights that have not been available to this point. DEP noted that research on the prevalence of cover of local corals by blue-green algae would also be worthy of note, and could be valuable for the preservation of area reef habitats.

7.9 Habitat and Environmental Monitoring

All elements that are proposed as mitigation sites (i.e., hardground restoration sites and habitat creation sites) will require monitoring before, during, and after implementation in order to guide specific mitigation decisions and ensure the success of each measure. Monitoring should include observation of the physical environment (scouring, sedimentation, etc.) as well as the biological communities, at both mitigation sites and adjacent areas. Recovery at impact sites should also be observed and recorded. Monitoring at sites *adjacent to* impact and mitigation sites should be carried out to ensure that sedimentation to adjacent reef areas does not occur. According to DEP, the minimal interval for monitoring should be 3 to 5 years, but NOAA Fisheries suggests a minimum of 5 years of monitoring.

Navy staff noted that if mitigation sites near their equipment were used, cables could be used in the transmission of real-time monitoring data. However, it appears that the most practicable mitigation sites are away from such equipment.

Monitoring data has more uses then simply tracking the progress of mitigation and ensuring the lost ecosystem functions are compensated. Monitoring on re-located rock substrates would provide information on the effectiveness/mortality associated with such bulk rock-recovery processes. Of course, monitoring at sites where reefs have been built to provide replication for research purposes will allow scientists to gather important information regarding constructed habitats and recovery that was difficult to find during previous projects.

NSU scientists also recommended consultation and participation with the U.S. Coral Reef Task Force (USCRTF), to whom success criteria and mitigation monitoring data should be supplied. USCRTF should also be apprised of the success of mitigation measures, and supplied with recommendations to improve future mitigation projects. NSU staff also recommended that the Jacksonville District utilize two recent U.S. Fish and Wildlife Service documents (USFWS 2003 and USFWS 2004) regarding the efficacy of mitigation efforts in the Pacific and Atlantic for guidance (respectively).

7.10 Ancillary Mitigation Issues

Quantification of compensation. Through the PERG process, questions were occasionally raised regarding the amount of mitigation that the Corps and local sponsor should provide. For example, the USFWS noted that mitigation should provide compensation for impacts to hard-surfaced channel walls due to attached livebottom communities. Also, NSU faculty re-calculated HEA values taking into account different assumptions than were used by the Corps and their analyses indicated that up to 50 acres of high-relief reef was required for mitigation. Because it was not within the scope of PERG to determine the amount of mitigation necessary for the project (values can be negotiated only among regulatory personnel and the Corps), PERG used only the mitigation values that have been formally proposed by the Corps to form the hypothetical basis for recommendations in this document. It is possible, however, that through the NEPA process, regulators will require additional mitigation or types/quantities of mitigation that differ from what has been proposed by the Corps.

Logistics. It is imperative that activities at all mitigation sites are minimum-impact, and that best management practices are carried out during the construction, restoration, and enhancement of reef and hardground habitats.

Timing. It may be possible for the Port to conduct certain mitigation measures prior to the initiation of navigation improvements, and Port staff indicated an interest in doing so. Unlike habitat construction, tire-removal could be conducted at any time, i.e., before, during, or after channel/basin construction. Initiation of reef enhancement at the sites south of the planned channel (third reef line) could also be initiated early.

Scientific references. PERG members suggested that several individuals outside PERG be contacted for assistance with guiding the mitigation process, particularly as it relates to relocation and recovery of hard and soft corals. Those personnel included Jennie Wheaton of the Florida Marine Research Institute for assistance regarding octocorals, Walt Jaap of the Florida Marine Research Institute for assistance regarding scleractinians, John Dodrill (850.922.4340), artificial reef coordinator for the State of Florida, and George Henderson of the Florida Marine Research Institute for Florida Fish and Wildlife Conservation Commission consistency.

8.0 CONCLUSIONS

Compensatory Mitigation Objectives. Like-for-like mitigation is an important criterion. The definition and goals of LFL mitigation should be adaptive, compensating the ecosystem for lost ecological services, but retaining as many of the characteristics of the impacted system as possible. However, the practicality of repeated application of the LFL paradigm was addressed by PERG. It was noted that simply creating artificial reef after artificial reef for all coastal projects would result in an excess of reefs that may be either depth- or structurally appropriate for mitigation purposes, but would not necessarily provide many of the important ecological services provided by reefs that have been impacted. Some in PERG indicated that restoration/enhancement could be considered LFL.

Additional Baseline Studies and Success Criteria. Before determining how well mitigation measures function and what the mitigation objectives are, a detailed assessment of the habitats and functions provided by the habitats that will be impacted should be carried out. At a minimum, a *qualitative* assessment of likely impacts should be conducted at each impact site. PERG members stressed the importance of *quantitative* data that would be used to establish more precise levels of performance for mitigation success criteria. Prior to relocation of hard or soft corals, assessments should be carried out. They should comprise *in situ* data collection to quantify the number, size, and species of corals (and other relevant fauna) within the impact zone. Donor and recipient sites for coral translocation must be identified also, and these must also be assessed for suitability and current environmental characteristics prior to carrying out mitigation activities. In addition to obtaining data on impact sites, obtaining baseline information at each of the proposed mitigation sites is necessary to determine the success of mitigation, particularly where habitat restoration or enhancement is planned.

Reef Enhancement Opportunities. Based on LADS maps, there appears to be an area of extreme low profile substrates south of the planned channel in the third reef line. The area appears to have been previously impacted, and therefore is a candidate site for reef enhancement or restoration. This site and mitigation option should be further investigated via field reconnaissance.

Reef Restoration and Preservation. Approximately 31 acres of Broward County hardgrounds associated with the second reef line and adjacent softbottom habitats are covered by discarded automotive tires that had been deployed in the early 1970s for use as artificial reefs. PERG participants agreed that restoring reefs and further protecting existing ones by removing tires would be a valid form of compensatory mitigation to be considered for impacts of the navigation project to the second reef line. There is additional appeal to include tire removal as part of the compensation package for navigation improvements. The project would be visible to the public, and could serve as a model program for environmental restoration. Since all tires cannot be removed simply through this mitigation program, non-governmental organizations (NGOs) and local sponsors could become involved, after having the Corps/Port provide somewhat of a "demonstration" program. NMFS voiced concern that any partial solution to the tire issue would be less favorable than a comprehensive plan.

Reef Habitat Creation. Where restoration and enhancement of reef resources are not available for use as mitigation, habitat creation has traditionally been offered as compensation for impacted habitats and lost ecosystem functions. Since new reef impacts would take place at water depths of approximately 40 to 45 feet (second reef line) and 50 to 55 feet (third reef line) for the channel expansion at Port Everglades, it was suggested that these two depth zones should be used at mitigation sites to achieve in-kind, LFL compensation. The species assemblage present at the impact site should be examined so that the replacement habitat can be specifically engineered to create habitats conducive for recruitment of a similar assemblage.

Siting. Determining locations that would provide the appropriate depths was discussed at length by PERG. Generally, any sites shallower than 40' were excluded from further consideration as they may attract only juveniles and smaller fish, and thereby would not adequately replace the impacted assemblages. Other possible locations at which reef habitats could be constructed include "reef-gaps." The gaps considered by PERG were those in the third reef line, which could provide sites for LFL reef construction to compensate for impacts to the third reef line due to navigation improvements. In case there is an excess of rock requiring disposal from the navigation project (i.e., over 50 acres), NSU faculty suggested some deep reefs (below 200 feet deep, or at 400+ feet) should be built. They noted that siting and monitoring could be achieved through use of ROVs.

Materials and Design. The use of habitat replacement materials must be carefully considered for logistical purposes, cost, and desired outcome. Materials should be selected following consideration of findings from baseline surveys at the impact sites and subsequent determination of success criteria. There was general consensus among PERG members regarding which material should be used for habitat construction: limerock. Another option is a coquina-based concrete (since concrete lasts longer) with crushed limestone veneer. Some PERG members displayed some concern for the strict classification of, and constructing reefs defined as, "high-relief" and "low-relief." Participants seemed to place emphasis more on reef construction materials and depth of placement to achieve biological goals, although NMFS and DEP noted its concern for LFL replacement (providing identical structure and reef profile as was in impacted areas). Following additional studies of the impact area and its resident biota, attempts should be made to imitate the structure of impacted areas.

Logistics. To increase the success of compensation through habitat creation, materials for both structure and biological recruitment ("seed" material or translocated corals) are necessary. Allow for some rock to be exported to mitigation sites in advance of dredging in the eastern portions of the project, thereby supplying a destination for corals translocated from the Outer Entrance Channel before it itself is dredged. If neither dredged nor blasted rock is available for advance placement (at mitigation sites) to receive relocated corals, pre-fabricated tetrahedrons could be installed at habitat creation sites so that no colonies are lost during blasting/dredging. Just as with the translocation of corals, it may be desirable to transfer seed materials/colonies and parent rock/rubble to habitat replacement sites. Timing of work should allow for maximum translocation of corals from impact zone and use of native substrate materials. Blasting/dredging should not occur in offshore areas until colonies can be translocated from impact sites and relocated to enhancement and reef construction sites. If no mitigation areas are yet available to receive corals, some colonies from the inner channel and outer channel could be relocated to reef modules in previously permitted Broward County reef areas between the second and third reef lines.

Value-Added Habitat Creation. PERG members suggested placing any mitigation reefs in such a way as to maximize their use as a platform for research. Reef modules/structures would be placed in lines, groups, or randomly, so as to produce replicates at various sites and at various depths. Findings may help scientists and resource managers make better decisions regarding reef construction in the future based on findings from examination of reef dynamics, particularly those involving long-term datasets.

Coral Relocation. NMFS typically advises that coral colony relocation constitutes a major part of avoidance and minimization criteria for impacts. The preferred manner in which to carry out relocation is to use colonies from impact sites to create an initial assemblage at mitigation sites. Corals should be relocated by experienced personnel using established methods.

Habitat and Environmental Monitoring. All elements that are proposed as mitigation sites will require monitoring before, during, and after implementation in order to guide specific mitigation decisions and ensure the success of each measure. Monitoring should include observation of the physical environment as well as the biological communities, at both mitigation sites and adjacent areas. Recovery at impact sites should also be observed and recorded. Monitoring at sites *adjacent to* impact and mitigation sites should be carried out to ensure that sedimentation to adjacent reef areas does not occur. NOAA Fisheries suggests a minimum of five years of monitoring.

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APPENDIX A

PERG Member and Participant List

PERG Member and Participant List

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APPENDIX B
PERG Meeting Notes

Port Everglades Reef Group
Meeting #1
12 June 2002
1000 hrs

Participants

SD	=	Steve Dial	Dial Cordy and Associates
BV	=	Bill Venezia	U.S. Navy
KG	=	Ken Geddings	U.S. Navy
DD	=	Dick Dodge	Nova Southeastern University
AS	=	Allan Sosnow	Port Everglades, Broward County
RS	=	Richard Spieler	Nova Southeastern University
PF	=	Pamela Fletcher	Broward County Dept of Planning and Environmental Protection
MJ	=	Mike Johnson	National Marine Fisheries Service
KB	=	Ken Banks	Broward County Dept of Planning and Environmental Protection
AW	=	Allen Webb	US Fish and Wildlife Service
TJ	=	Terri Jordan	US Army Corps of Engineers
JE	=	Jason Evert	Dial Cordy and Associates
EK	=	Ellen Kennedy	Port Everglades, Broward County

Not in attendance

HH	=	Harold Hudson	Reef Relief/NOAA Restoration
KL	=	Ken Lindeman	Environmental Defense Fund

The following are paraphrased statements, indicating some of the issues that were discussed at the meeting. It is not intended to be a direct or complete transcript of the meeting. Corrections and clarifications should be made at next meeting, if necessary.

KB Minimum stability of reefs at water depth of 40 feet is 3-4'
DD No rock will be available from 3rd reef line for use in art. reef construction due to geology
SD Target what qualitative impacts are, and replicate those in the art. reefs
DD Use science to guide plan, but also use placement/materials and resulting data to gain knowledge of art reefs
KB Much of sites are already used, schedule for use, or for research
PF Permitted art reef areas are mapped to 150' deep
SD Target snapper/grouper taxa, as they are the managed spp. under EFH, which we are trying to replace
RS If reefs are placed shallower than 40', they may attract only juveniles and smaller fish
TJ Orientation of reefs that will cover 50 total acres, i.e., spaced, in a line, groups, etc.?
SD Use different depth zones
KB LR & HR is meaningless as biology goes
BV Use of cables south of channel to take real-time baseline and monitoring data?
JE Are we stuck with federal like-for-like constraints, or can we be more creative?
AW Hesitant to go outside in-kind compensatory mitigation
DD Coral replacement to any art reef to decrease HEA acreage calculation?
MJ Replacement of any and all heads is recommended.
AS Can't we simply use the best information available to do the art reefs? Why worry about the design strictly from an academic standpoint when the first priority is mitigation?
KB limestone is best substrate
MJ Like for like mitigation should be the rule, but have room for some experimental
KB Large plots only available @ 25', 65', (or *over* 75'?)
SD Let's try 2/3 of acreage at shallow and 1/3 at deep
RS What is like-for-like? Depth? Substrate? Spp. assemblage?
AW Yes, like-for-like = depth
RS Mitigation for 3rd reef impacts should involve art reefs exposed to Gulf current to allow for in-kind biota to recruit (so maybe depth not only consideration, but position is also important…)
SD Prefabricated reefs better biologically or cheaper? Logistic difficulties in deep water?

KB Deeper water with prefabs sometimes better logistically - no small habitats to try to avoid
AS Decrease time-lag impacts by replacing boulders in channel (since that's what would be removed)?
?? Mortality would probably be high (of live-bottom orgs assoc with boulders), and boulders *extensively* cover channel bed, so that would be very expensive
KB In another case, rock-rubble dumped offshore made nice habitat
SD Can rock-rubble replace LR habitat? We could extend KB's already existing site
JE Restoration opportunities available, or other non-art-reef-building options?
KB Cover tires? (2 million of them?)
DD Tire removal has been done before
MJ Willing to entertain the idea
SD Propose 30 acres in 40'-60' depth; 10 ac in deepwater, and 10 acres credit for restoring?
SD How about reef design?
MJ Concrete colonization not as great as limestone
RS Not necessarily – plus, concrete may last longer
TJ Harold Hudson's concrete = coquina-based concrete with limestone crushed
AW Is settling prohibitive?
KB No, but scouring occurs
JE Number of separate reef structures (replicates) at each depth?
RS Some experimental power with 8 reps - (for 30 acres)
SD Configuration and spacing? Specific siting? GIS data?
BV No Navy structure in permitted reef sites.

Other issues mentioned after dismissal:
?? value of relocation of corals? value of relocation of tire removal? (with respect to values calculated via MBRT or HEA)
MJ relocation of corals is actually a form of avoidance and minimization
RS need for baseline data
SD for now, we need to use what we know, and keep planning mostly conceptual
?? a need for physical/sedimentation monitoring on adjacent corals (impact or art reef site?)

Port Everglades Reef Group
Meeting #2
26 August 2002
1330 hrs

	Participants	Phone Number	E-mail
AS	Allan Sosnow		
JE	Jason Evert	904-241-8821	jevert@dialcordy.com
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SR	Stacey Roberts (DEP)		

Not in Attendance

Bill Venezia	U.S. Navy
Ken Geddings	U.S. Navy

The following are paraphrased statements, indicating *some* of the issues that were discussed at the meeting. It is not intended to be a direct or complete transcript of the meeting. Corrections and clarifications should be made at next meeting, if necessary.

re: Tire Removal
MJ: tire removal should be considered in-kind
KG: in-kind for tires at the 2nd reef line
JE: tire removal could be done in advance of impacts
AS: secondary impacts due to tire removal?
RS: Robin has footage of tires
[KB and PF acknowledged that they also have footage]
JE: the work would be preventative and restorative, depending on sand flat or 2nd reef line
KG: should start at southern extent

re: Construction of Artificial Reefs in Geologic Gaps in 3rd Reef Line
TJ: source of available rock from blasting in port/channels only, not offshore
VK: 1 ac. limestone boulder = $300,000 if purchased
KB: hydrodynamics to 2nd reef – recruitment (??)
HH: stability of placement in such locations?
KB: stability analyses necessary
KG: sure meets 3rd reef in-kind replacement!
KG: cable corridor project - fiber optics (??)

re: Materials
KG: FMRI says marl boulders are best
HH: concrete best for stability - use concrete to hold rocks in place. Therefore, you get additional benefit of use of rocks by benthos.
HH: must mimic structure of impacted habitats
HH: engineering/stability - 20-25' of water - only 3' high necessary
TJ: depths of 40 - 60'?

RS: some impacts will be within current channel, and channel critters (the larger ones) are different than what would be at artificial reef. We need to do something to replace those - not just make reef, i.e., place reef with exposure to Gulf current to allow for big fish
AS: science done in impact areas (??)
KG: pilot testing?
AS: yes
KG: i.e., for tire removal, gap-reef-fill, etc.
AS: go with high-relief if better biologically - using less low-relief = less impact on existing systems on which the reefs would be built
MJ: however, still need to replace like with like
KG: true, low for low, high for high

re: Translocation of Corals
DD: minimum size: 12-15 cm (4 ¾"- 6") diameter
MJ: agree with Fish and Wildlife Coordination Act Report recommendations to relocate those over 6" (15 cm) in diameter
DD: that equates to 15-yr-old corals
MJ: agree with idea that translocation fills the avoidance requirement. Also decreases time-lag value used in HEA. a weighted % (??)
JE: priority corals (i.e. rare spp.) and those with high likelihood of survival?
KG: relocation survival rate?
KB: over 90%
TJ: should conduct site visit for next meeting to determine if and how many corals to relocate
DD: Broward County hardgrounds: relocation of 1,000 - 1,500 corals on 10 acres will occur
HH: for the Port Everglades project, should soft corals be relocated also?
MJ: hard corals more important due to longer recovery times
HH: older colonies of soft corals can/should be translocated
JE: are larger colonies more reproductively active and therefore more valuable?
VK: yes, they are.
VK: also, corals should not be translocated twice
VK: many colonies translocated to one area is better then multiple sites
JE: allowable mitigation? (?)
KB: Budget for translocation? Schedule?
TJ: To begin in 2004, or if Water Resources Development Act not passed by Congress, then it would be 2005
TJ: Construction budget includes mitigation components
AS: Port is in favor of mitigation prior to construction
KG: monitoring itself does not equate to success criteria, which should be established early

[Other topics discussed included setting up a site visit and other state personnel that may become involved. Those personnel included Jennie Wheaton for octocorals, Walt Jaap for scleractinians, John Dodrill (850.922.4340) as state artificial reef coordinator, and George Henderson for FWC consistency. A pre-meeting conference with Nova faculty was held to determine availability of fishery data for the impact areas; at that conference, DD/RS noted that any efforts for restoration should be minimum-impact, and that timing should correspond to maximum recovery of corals in impact zone, i.e., interior channel/basin blasting produces rock for use in art reef constr (in reef gaps?); coral translocated to art reefs/restoration areas prior to dredging in outer channel/3rd reef.]

Port Everglades Reef Group
Meeting #3
21 November 2002

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JK	Jocelyn Karazsia	305-595-8352	jocelyn.karazsia@noaa.gov
PQ	Pat Quinn	954-262-3642	quinn@nova.edu
GG	George Getsinger	904-232-2580 x121	george.getsiuger@noaa.gov
By Conference Call:			
KM	Keith Mille	850-922-4340 x207	keith.mille@fwc.state.fl.us

The following are paraphrased statements, indicating *some* of the issues that were discussed at the meeting. It is not intended to be a direct or complete transcript of the meeting. Corrections and clarifications should be made at next meeting, if necessary.

re: Overall picture

DD: USCRTF: See datasheet from DD and RS
AS: Organizations already doing monitoring?
RS: ¼ internal fish survey data
JE: Does USCRTF provide guidance, science, etc.?
DD: No
DD: pt. #2, re: baseline
RS: see pt. #3; coral transplant survival rate >80%

re: Tire removal

RS: 1600 tires removed, then those areas covered again - they move
GG: Tires = bad substrate
KB: To get credit for acres, must remove all tires in front of reef also [that may move onto area credit was given for]
RS: credit for depth of tires
RS: hand removal at reef line - expensive
KM: Sunny Isle long-term (11-yr) data now available
GG: Trish mentioned dumping limestone on tires to keep them from moving
KG: Priority tires, [i.e., those at most sensitive areas]?
GG: Restoration money? [Section 1135/206?] Amount/limit of $$$??
AS: Costs?
RS: use tires for to compensate for channel impacts also
KM: calc. amount of tire damage by ac. to get credit
DD: use acres protected as credit in HEA
KG: Use # tires removed as success criteria
[JE calcs: 5 sf/tire; 8,712 tires/ac; $87,120/ac; x 25 ac = $2,178,000, vs. 25 ac limestone for $7,500,000]
AS: a swatch approach won't work - tires would be replaced
JE: Value/tire could be judged by distance to, and current impact on, reef
KM: economy of size
KM: Monitoring
AS: Port willing to investigate scope of impact to 2nd reef line

Port willing to remove tires near impact area
Port willing to investigate other funding sources
GG: Partial solutions not good

re: Construction of Artificial Reefs in Geologic Gaps in 3rd Reef Line

KG: Pipeline permit applied for at RG2
KB: Some hydrodynamics/sand flow occurs there
??: "creation" of new gap = 3rd reef impacts
JE: RG2 only several hundred feet from impact area?
TA: Section 1135 project for area of 3rd reef line impacts?
DD: Improve 3rd reef south of impact area? And study for mitigation goal purposes
TJ: Move reef off from gaps
JE: Scattered is more natural
KG: 1st find out about 3rd reef evaluation south of impacts
KG: Do both reef gap and improve 3rd reef line
JE: Is in kind more flat, elevated plateau?
RS: Examine 3rd reef line for assemblage to know what in-kind is
RS: Has data on materials
TJ: Sunny Isles - materials
KM: Artificial reefs permitted via Corps doc
KG: "habitat replacement" should be used rather then "artificial reef" (which in effect means "fishing spot")
JE: Use Broward County sites?
KM: Either way
JE: Materials?
RS: Data available, and from other sources
TJ: Seed materials/rock removed- decreases HEA recovery intervals
PQ: Tetrahedrons
AS: Place tetrahedrons in restoration site to receive corals prior to impacts
AS: Need to get GeoTech, but can stage work W to E in MTB and entrance channel, Southport Access Channel is last
KG: agree w/ DD; prefer use of natural limerock component in some way
GG: Use small rubble/rock in channel to seed-source new mitigation site; it's better than the sand as a source
KG: Anticipate sinking/scouring/covering by sand
AS: Rock in channel was from punch-barge, not cutterhead - 2 types of equipment may be necessary: pull-up rubble, then blasting.
GG: Build reef with that in mind
KG: Gulfstream pipeline EIS - data on recovery
JE: Need assistance with revising/adjusting HEA to accommodate seed-source and coral translocation
KB: Plenty down there to relocate
KB: Gorgonians difficult but do able
JE: Replication still on table, given smaller 20% of acreage still given
DD: Yes
KB: 1 acre still huge!
DD: Especially with respect to corals
AS: Success criteria? Responsibility for results?
KG: Big picture considered - research consideration. Gulf Stream – 15-year monitoring
JE: Yes, but credit?
KG: Long-term monitoring, i.e. over 3-5 years should be done
TA: Centralized database for cumulative impacts
AS: Sources to reduce duplication of efforts
KG: Kevin Madley (FMRI) database - habitat classification
JE: Recipient sites for coral? Like for like?
KG: Uncertainty of tire re-impacts - all corals might better go to artificial reef structures (habitat replacement units)
KG: Dynamic positioning of dredge? Monitor impacts of equipment

Port Everglades Reef Group
Meeting #4
30 April 2003

	Participants	Phone Number	E-mail
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The agenda for this meeting included participant introductions, a report from the Corps on Port Everglades project status, explanation of the goals of PERG, and soliciting comments/edits for the draft document. First, comments on the overall structure/conteut were received, then specific comments on Sections 6.0 and 7.0 of the document were noted by the facilitator. In addition, various parties submitted hardcopies of information pertaining to agency mitigation policies and hand-written comments noted on copies of the draft document itself. The following are some of the issues raised by PERG members. It is not intended to be a direct or complete transcript of the meeting. Corrections and clarifications should be submitted to the facilitator, if necessary.

Comments on Draft PERG Document:

Section 4.0 (Mitigation Guidelines and Environmental Policy)
- state if no formal hardground policy exists per each agency
- intro: recognize stakes- intent, mandates, - ea. diff. laws- e.g., H20 qual cert req fr state, but no permit requirements
- refer to Section 7.1
- Broward has dredge and fill up to 3 miles out
- use statement of Port toward environment—Port Master Plan (Master Vision 2020) on web
- check with Office of Protected Species, NMFS- ask JK for coordination/ mitigation/ policy

VK: Where do water quality impacts come into play with regard to impacts (particularly run-off from Port properties and indirect impacts)? Is there some type of compensation provided for these impacts? Also, do these impacts decrease likelihood of success of mitigation?

DD: Define HR (high-relief) and LR (low-relief) and substantiate the classification, or use another more specific classification system, and use such a revised system in the description of impacts, mitigation design and construction.
KM: Add impacts table-
[JE note: Add compensation table as well]
KM: Re: recovery rate, when was last time channel was dredged?
VK: Examine size classes of corals in impact zones to more accurately obtain recovery rates.
DD: ½ cm per year depending on spp. and water clarity
VK: many exhibit a non-linear growth rate
JK: take into account indirect impacts due to water quality decreases?
VK: monitoring for adjacent impacts?
DD: sedimentation impacts?
BR: impacts from de-watering of dredged sediments? impacts to water quality from dredge operation?
DD: For Section 7.7, include HEA calculations
TJ: MBRT?
VK: Relief, substrate, and depth are operative elements of "like-for-like" mitigation

DD: depth alone does not accurately predict the assemblage at the 3rd reef line, TOP of reef is the operative depth
VK: Conduct transects, in belt form:

#colonies	cover
0-5 per size class/sq. meter	
6-10	
11-15	

for hard corals, octocorals, sponges, macroalgae

BR: ID and locate corals for translocation
KB: Quarterly fish counts
VK: Video is quicker
TJ: Encrusting corals are likely to be damaged, so not as good as candidates for relocation
TJ: Harold Hudson should be consulted for translocation methods
KM: Mark/delineate effective impact areas underwater for use by divers to locate outer boundaries
VK: match diversity at recipient site
TJ: will send Broward County plan- [?]
BR: conduct benthic infauna studies in reef gaps
KM: differentiate LADS vs. LIDAR- use depths
multi-spectral imagery??

Section 7.3:
- enhancement area: remove overburden?
- add historical information (Great Lakes Dredging?)
- 79-81 Corps dredging in Harbor Phase II [??]

- {use area [?]} Avoidance/minimization

KM: use picture of area in paper
See KB, "Section 9" observation site [??]

Section 7.4:

KB: include Horn & Mille paper – available electronically

- 0.3 tires/square foot 1600 off of 100'x50' pulled by Robin
- get Robin's final report prepared for NOAA

KB: removal of corals difficult; encrusting corals break-up
KB: can get $/ac cost for Broward [tire removal cost, or disposal?]
DD: recovery rate, direction of movements of tire study
KB: armiflex to cover tires when pushed/placed offshore & placed in row- new consideration?
TJ: method- cutterhead?
KM: no economy of scale [?]
[JE note: AS supplied tipping fee amounts/ 100K tires - $1 per tire for recycling]
TJ: partnership for solid waste disposal?
KM: has info for disposal of tires

APPENDIX E-5

NOAA Fisheries--Developed Mitigation Plan for Impacts to Reefs and Hardbottom Habitats

NOAA DISCUSSION DRAFT
CORAL PROPOGATION AND ACTIVE SPECIES ENHANCEMENT PROGRAM
June 7, 2013

Summary
Expansion of the Port Everglades Outer Entrance Channel will remove 20.34 acres of coral reef, and an additional 117.49 acres of reef is expected to be impacted by the anchoring of construction equipment and sedimentation (Figure 1 and Table 1)[1]. NOAA recommends the Jacksonville District Corps of Engineers (USACE) mitigate these impacts by propagating corals at one land-based nursery and approximately six nursery sites located offshore of Broward County and then transplanting the reared corals to natural reefs to enhance those reefs or to restore degraded sites. NOAA estimates this approach would require 20 years to complete and would cost approximately $28M to $36M. NOAA's recommendation is based on careful evaluation of the expected losses of scleractinian coral and octocorals from the expansion of the port's Outer Entrance Channel and the successes of coral propagation and enhancement programs in Atlantic and Caribbean waters.

The mitigation in this proposal would expand upon existing NOAA and partner programs that have been developed to manage and implement coral reef active propagation and population enhancement efforts. Specifically the work that was greatly expanded, but no longer supported, by the American Reinvestment and Recovery Act project titled *Threatened Coral Recovery in Florida and the U.S. Virgin Islands*. In Broward County, Florida, this project has been to date implemented through a partnership between NOAA, Nova Southeastern University, Broward County, The Nature Conservancy, and other coral restoration partners in Florida. NOAA would anticipate a continued partnership with these and other institutions to implement this mitigation project.

The recommended approach focuses on living corals, not on the reef framework (geologically described as rock and fossilized coral) that form the complex, three-dimensional structure upon which living corals occur. NOAA is still evaluating options to address impacts to the reef framework. Options include the beneficial use of excavated dredge material if that material meets size, shape, and quality specifications; emphasizing in the mitigation plan coral species that have significant three-dimensional structure (e.g., *Acropora cervicornis*); a combination of either approach; or approaches not yet considered. NOAA has not yet estimated the amount of structure that would need to be created, and we would like to work with the USACE and other resource agencies to determine the best path forward. Based on recent coordination with Florida Department of Environmental Protection (FDEP), we understand the FDEP would like to see up to 5 acres of boulder reef in the mitigation plan to offset the loss of reef structure. NMFS believes this approach has merit combined with the approach described in this proposal and we plan to further develop this with USACE and FDEP. Please note these comments only address the impacts to coral and hardbottom habitat; impacts to seagrass, mangroves, tidal creeks, and other habitats require separate discussions.

The cost of NOAA's recommended approach for mitigating the coral impacts is still under development and appears to be similar to the $32.4M estimated by the USACE for using boulder piles for mitigation (DCA 2011b). The proposed coral propagation and outplanting program has the added benefit of being designed to maximize the chances of successful natural coral reproduction, larval transport, settling and colonization into new areas, and genetic mixing required for survival and recovery of the species. Furthermore, this proposal is consistent with the NMFS *Acropora* Recovery Strategy (under development) and other coral recovery plans for coral species that may be listed under the Endangered Species Act. Next steps are described below.

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[1] Additional corals are also present along the channel wall and existing channel bottom

Background
NOAA is a cooperating agency with the USACE for development of the Environmental Impact Statement (EIS) examining the Port Everglades expansion project. NOAA expects the EIS will describe a project alternative that we have determined to impact to 137.83 acres of coral, coral reef, and hardbottom (collectively referred to here as "reef"). NOAA informed the USACE that boulder piles would not offset the reef impacts and alternative mitigation approaches should be examined (see NOAA letter dated July 7, 2011). NOAA recommends the USACE mitigate the coral impacts by propagating coral colonies within nurseries and then outplanting the colonies to suitable sites off the Broward County coast. Coral colonies from propagation nurseries (Rinkevich 2005; Epstein et al. 2001; Becket et al. 2001; Horoszowski-Fridman et al. 2011) and salvaged from impact areas (Stephens 2007; Monty et al. 2006; Brownlee 2010; Thorton et al. 2000) have been successfully outplanted to natural and artificial substrates. NOAA's Restoration Center successfully uses this approach to mitigate damages to Caribbean reefs from vessel groundings, and this mitigation approach is rated the highest for southeast Florida by 25 coral resource trustees and scientists working in Florida and the U.S. Caribbean (Ladd 2012).

The key steps in formulating a mitigation strategy for the reef impacts are: (1) quantifying the reef impacts, (2) examining alternatives for offsetting the impacts, and (3) selecting an alternative based on cost, likelihood of success, and risk of failure. While additional information is needed to fully describe each of these key points, the initial screening has been done with the existing information and is discussed below.

Quantifying the Reef Impacts
Based on the information received from the USACE, NOAA anticipates the draft EIS will describe a tentatively selected plan that we have determined would result in direct impacts from dredging to 20.34 acres of reef (see Figure 1 and Table 1). An additional 117.49 acres of reef impacts are expected from anchoring of construction equipment and sedimentation. The number of corals within the 20.34-acre dredging area is on the order of 157,000 (DCA 2006); the number within the 117.49-acre indirect impact area has not been estimated. The five available survey reports for the direct impact area shows 29 species of scleractinian corals and 12 genera of octocorals are present (Karazsia and Wilber 2011). While staghorn coral (*Acropora cervicornis*), currently threatened and proposed as endangered under the Endangered Species Act (ESA), was not seen in towed-camera surveys (DCA 2010), these areas are designated critical habitat for *Acropora* spp., and staghorn coral occurs within 150 meters of the channel (Gilliam and Walker 2011). Thus, the 137.83 acres of reef and hard bottom impacts identified also constitute 137.83 acres of designated critical habitat potentially affected by the project. Additionally, NOAA has proposed ESA listing for seven Atlantic and Caribbean coral species, six of these species occur in the project area (DCA 2006).

As described in more detail later, NOAA estimates 195,000 to 250,000 corals need to be outplanted from nurseries to offset the impacts to coral from expanding the Port Everglades Outer Entrance Channel. NOAA's estimate assumes impacts to corals would be minimized by relocating many corals from the impact area to suitable locations; the estimate would need to be refined once the details of the relocation plan are clearer[2]. For current planning purposes, NOAA assumed the coral species and size classes presented in Table 2 would be relocated from impact areas prior to destruction or modification of coral reef habitat. More or less impact minimization would result in a lower or higher mitigation requirement. The cost of project minimization is not included this proposal.

[2] While coral impacts may be minimized through transplanting, considering the magnitude of the project, it may not be logistically feasible to transplant small coral colonies. Also, except for the anchoring locations, it may not be prudent to transplant coral colonies from the indirect impact area.

Alternatives for Offsetting the Impacts

Boulder Reefs: Based on an email from USACE dated May 31, 2013, NOAA anticipates the draft EIS will propose creation of 19 to 27 acres of boulder piles as compensatory mitigation at a cost of $12M to $13M and the EIS will describe that coral impact minimization measures (i.e., coral relocation) will cost an additional $8M. This approach aims at replacing the three-dimensional structure but does not compensate for the replacement of the living organisms. Boulder reefs have a high of risk of failure because the boulders do not mimic a natural reef system. Miller et al. (2009) documented an overall lack of similarity between natural reef and artificial reef assemblages. In addition, Gilliam (2012) concluded the length of time boulder reefs require to mitigate lost reef resources in southeast Florida, assuming a total loss of the impacted community from events such as dredging, is longer than 17 years (the age of the oldest boulder reef assessed in this study).

Coral Propagation and Transplanting: Ladd (2012) describes a thorough review of 11 reef mitigation and restoration options in southeast Florida. Based on consultation with 25 coral scientists and resource trustees from Florida and the U.S. Caribbean and a review of over 190 publications, enhancement of coral populations by nursery propagation and outplanting was preferred over other mitigation approaches due to logistical practicability and scientific feasibility. As noted above, coral propagation and outplanting, predominantly using *Acropora* spp., has been successfully used over the past decade in Florida and the Caribbean for reef rehabilitation. These efforts focused on *Acropora* spp. because these species exhibit faster growth rates than other Caribbean coral species, reproduce predominantly via asexual fragmentation, and can be propagated efficiently using both in-water and shore-based nurseries. When located where the likelihood of natural and human threat is low, propagation nurseries provide a low risk setting for growth of coral fragments (Herlan and Lirman 2008). While work to date has largely focused on *Acropora* species efforts are underway to transfer these successes to other coral species.

Scientifically vetted best practices for nursery propagation, outplanting, and monitoring have been developed and used by nursery managers in the Florida Keys, Broward County, Puerto Rico, U.S. Virgin Islands, and other Caribbean islands to reproduce *Acropora* spp. asexually (e.g., Johnson et. al 2011). Small fragments less than five centimeters in diameter are collected from the reef and held in an underwater or tank-based nursery environment through their juvenile life stage. Offshore nurseries are sited balancing a number of factors including, among others, appropriate habitat and water quality conditions, potential for future impacts, permitting. Once the stock nursery population is established, no more coral is collected from natural reef communities. The physical and genetic origin of each coral is tracked from fragment collection to ensure that both nursery and outplanting operations are done in a scientifically responsible way. Regular maintenance is performed on nursery structures and the corals themselves to ensure all are free of coral competitors and predators. Once coral fragments have grown to a size where the probability of survival on natural reef has increased to an acceptable level (this usually requires 12 to 18 months), the corals are outplanted to the natural reef.

Similar to nursery siting, outplanting sites are selected balancing several factors to maximize success. During outplanting, care is taken to ensure external stresses are minimized and that a population with an acceptable level of genetic diversity and environmental tolerance is developed. Algae and predators are removed from the outplanted corals until they are firmly established on the reef. A stock population is maintained within the nursery to provide new colonies for outplanting. The reduced levels of competition and predation, compared to natural reef communities, allow corals growing in a nursery to allocate their energy towards growth, and growth rates often exceeding those found in published studies, with small five-centimeter *A. cervicornis* fragments generating in excess of 50 centimeters of linear extension annually and 400% increase in biomass (personal communication to Tom Moore, NOAA Restoration Center; personal communication from Sean Griffin, PhD, NOAA Restoration Center, December 2012).

Thousands of 2nd and 3rd generation *Acropora* spp. corals have already been propagated and grown to maturity using these methods, including several sites in Broward, Miami-Dade, and Monroe Counties, Florida (TNC 2013; Young et al. 2012). When coupled with advanced genetics, nursery-reared corals with high survivorship potential can be outplanted to both healthy and degraded reefs to enhance the genetic diversity and size of remnant coral populations. These supplemented corals improve local reef structure and function but more importantly increase the likelihood of successful sexual reproduction[3] and contribute directly to the pool of coral larvae available to colonize adjacent reefs. Therefore, in addition to enhancing reef conditions generally, propagating and outplanting acroporids also serves the function of supporting the conservation goal identified in the final rule designating critical habitat for Acropora (73 FR 72210).

While much of the attention in the Atlantic and Caribbean to propagate corals has been directed towards *Acropora* spp., efforts in the past two years by NOAA and partners, including The Nature Conservancy, The Coral Restoration Foundation, Mote Marine Lab, University of Miami, Nova Southeastern University, Florida Fish and Wildlife Conservation Commission, The National Park Service, Puerto Rico Department of Natural and Environmental Resources, Sea Ventures Inc., Reef Scaping Inc., have focused on other scleractinian corals (e.g., *Madracis mirabilis* and *Dendrogyra cylindrus*). Techniques for propagating these species are still under development, and the life-history characteristics of most other species would result in longer nursery times before outplanting can occur. The mitigation for Port Everglades would need to balance the relative certainty of success using *Acropora* spp. for propagation against the need for species diversity.

While replacing coral colonies is an essential component of the reef mitigation, replacing the three-dimensional structure of the reef also is important. Beneficial use of excavated dredge material, assuming the material meets size, shape, and quality specifications, is one option for providing this structure. Another option is to use coral species that provide significant three-dimensional structure through their normal growth patterns (e.g., *Acropora cervicornis*). NOAA has not yet estimated the amount of structure that would need to be created, but is happy to work with the USACE, FDEP, and other resource agencies to determine the best path forward. Based on coordination with Florida Department of Environmental Protection, we believe that up to 5 acres of artificial reef creation may be appropriate to offset the loss of reef structure if combined with the approach described in this proposal.

Selecting an Alternative Based on Cost, Likelihood of Success, and Risk of Failure

Using Coral Propagation to Address the Impacts: NOAA recommends using Size/Species Frequency Distribution Equivalency Analysis, describe the reef ecosystem services that would be lost from the proposed Port Everglades expansion. As described in Viehman et al. (2009), this modified type of Habitat/Resource Equivalency Analysis (HEA/REA) uses a resource-to-resource method that references the number of organisms lost and the number gained through mitigation. In the coral reef environment, this approach examines the size-frequency distributions at the species or functional group level to reflect the life history strategies of different corals and allows representation of the typically non-linear relationship between services and colony size, thus providing insights into ecological function. Using this approach, the metric for scaling becomes a coral colony year (CCY). A CCY is not equal to coral age. CCY is a proxy for services provided or lost during a one-year period for a particular size and type of coral. The key inputs into this analysis are the size-by-species distribution and recovery time. The analysis also reflects economic considerations and other inputs used in REA and Habitat Equivalency Analysis, such as relative function, time to maturity, and project lifespan. Importantly, this analysis can

[3] There is a positive correlation between population size or density and the mean individual fitness (often measured as *per capita* population growth rate) of a population or species; this phenomenon is known as the Allee effect (Courchamp et al. 2008).

help determine the amount of compensatory mitigation needed to offset the expected losses from the Port Everglades expansion.

Using this analysis, NOAA estimates a 20-year program is needed to mitigate for the loss of corals within the direct and indirect impact areas from expanding the Port Everglades Outer Entrance Channel. This 20-year program would include six offshore nurseries and one land-based nursery to produce, outplant, and monitor enough corals to achieve the targets of surviving outplants. Existing in-situ and land based nurseries, located near the Port in waters offshore Broward County and managed by Nova Southeastern University, will likely be expanded and new sites added. The decision on species to be propagated and outplanted will be based on the state of the science and adaptive management. It is reasonable to expect that this program would result in outplanting of 195,000 to 250,000 nursery-grown corals depending on the species mix.

Adaptive Management: As with all mitigation projects, sound evaluation criteria, performance goals, capacity for adaptive management, and appropriate risk considerations are key. For example, studies are in progress to evaluate the target coral densities in areas to be outplanted at restoration sites to maximize success. Results from these studies will be incorporated into the outplant site selection plan. Further, outplanting site selection should reduce location-based sources of risk; however, should a site perform poorly due to local environmental conditions, an alternate site would be identified. For this project, NOAA is planning for a robust monitoring and evaluation program be included to assess the performance of both nursery operations and outplant survival against pre-established performance criteria. NOAA recognizes specific measures and estimated costs will need to be negotiated with the USACE for the final agreement. Given the extended duration of project implementation and the potential for a shifting baseline, performance goals should be established relative to the performance of other coral population enhancement programs and general reef health in the region. Deviations from performance goals would be addressed through the adaptive management framework.

Risk Management: The project would manage risk of failure by using six offshore nurseries and one land-based nursery, in addition to numerous outplanting locations, in order to maximize work windows, decrease exposure to localized stressors, and provide overall redundancy. Disadvantages of in-water coral nurseries include exposure to hurricanes, predators, diseases, extreme weather events, and tampering or inadvertent damage by the fishermen and boaters. Careful planning, monitoring, outreach, and education on fishing and anchoring issues and careful nursery site selection can decrease these risks.

NOAA also recommends final plans include contingencies to allow for recover from a catastrophic event that would otherwise not allow for project competition and/or meeting project goals. Such a contingency would need to allow for complete infrastructure replacement as well as sufficient operational funds to allow for recovery of the program. This is currently estimated to be $6.9M to 8M.

These risk management strategies are offered as discussion points. An examination of "force majeure" provisions in federal mitigation banking instruments may assist in moving this discussion along. NOAA recognizes specific contingencies and estimated costs will need to be negotiated with the USACE for the final agreement.

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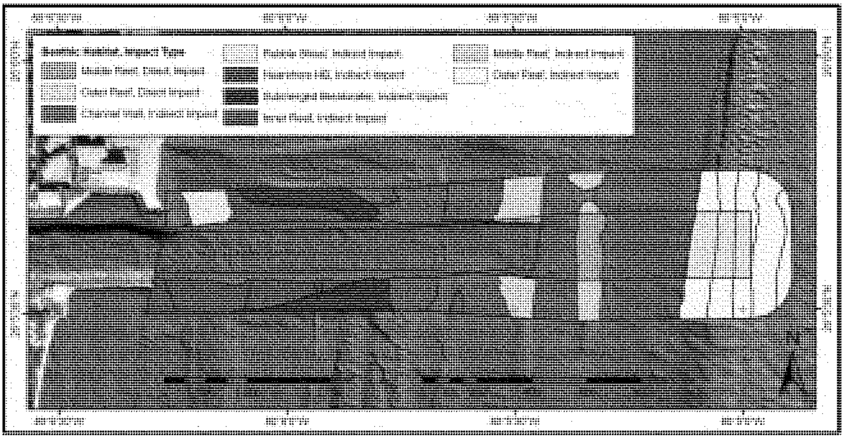

Figure 1: Coral Reef Habitat Types within the Port Everglades Expansion Area (from Walker et al. 2009)

Table 1: Coral Reef Habitat Types within the Port Everglades Expansion Area (from Walker et al. 2009)

Direct Impacts

HABITAT	TYPE	MODIFIER1	AREA (ft²)	ACRES	TYPE ac
Coral Reef and Colonized Hardbottom	Outer Reef	Aggregated Patch Reef**	301	0.01	13.54
		Spur and Groove	154971	3.56	
		Linear Reef-Outer	180259	4.14	
		Colonized Pavement-Deep	254450	5.84	
	Middle Reef	Linear Reef-Middle	296089	6.80	6.80
Inlet Channel Floor	Inlet Channel Floor	Inlet Channel Floor	2341644	53.76	53.76
Unconsolidated Sediments	Sand	Sand	1245485	28.59	28.59

Indirect Impacts

HABITAT	TYPE	MODIFIER1	AREA (ft²)	ACRES	TYPE ac
Coral Reef and Colonized Hardbottom	Outer Reef	Ridge-Deep	178647	4.10	28.26
		Aggregated Patch Reef**	257808	5.92	
		Spur and Groove	265158	6.09	
		Linear Reef-Outer	245716	5.64	
		Colonized Pavement-Deep	283893	6.52	
	Middle Reef	Linear Reef-Middle	692024	15.89	15.89
	Inner Reef	Linear Reef-Inner	[illegible]	13.52	13.52
	Nearshore HB	Colonized Pavement-Shallow	[illegible]	[illegible]	[illegible]
		Ridge-Shallow	[illegible]	[illegible]	
Rubble Shoal	Rubble Shoal	Rubble Shoal	208071	4.78	4.78
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Inlet Channel Wall	Inlet Channel Wall	Inlet Channel Wall	661113	15.18	15.18
Unconsolidated Sediments	Sand	Sand	2413861	55.41	55.41

**** Aggregated Patch Reef is considered 50% reef/50% sand therefore the polygon area has been reduced by 50%**

Table 2: Coral species and size classes assumed for relocation outside of the project area (modified from Karazsia and Wilber 2011, table 4). Note for octocorals, we would expect that different size classes would be relocated. The * indicates the species has been documented within 150 meters of the federal channel.

Species	Size Class	Documented in the project area	ESA listing status
Acropora cervicornis	all	Yes*	listed
Acropora palmata	all	No	listed
Agaricia lamarcki	≥ 5 cm	Yes	proposed threatened
Dendrogyra cylindrus	≥ 5 cm	No	proposed endangered
Dichocoenia stokesii	≥ 5 cm	Yes	proposed threatened
Montastraea annularis	≥ 5 cm	Yes	proposed endangered
Montastraea faveolata	≥ 5 cm	No	proposed endangered
Montastraea franksi	≥ 5 cm	No	proposed endangered
Mycetophyllia ferox	≥ 5 cm	Yes	proposed endangered
Colpophyllia natans	≥ 5 cm	Yes	n/a
Dichocoenia stokesii	≥ 5 cm	Yes	n/a
Montastraea cavernosa	≥ 5 cm	Yes	n/a
Diploria clivosa	≥ 10 cm	Yes	n/a
Diploria labyrinthiformis	≥ 10 cm	Yes	n/a
Diploria strigosa	≥ 10 cm	Yes	n/a
Eusmilia fastigiata	≥ 10 cm	Yes	n/a
Madracis decactis	≥ 10 cm	Yes	n/a
Madracis pharensis	≥ 10 cm	Yes	n/a
Manicina areolata	≥ 10 cm	Yes	n/a
Meandrina meandrites	≥ 10 cm	Yes	n/a
Mussa angulosa	≥ 10 cm	Yes	n/a
Mycetophyllia aliciae	≥ 10 cm	Yes	n/a
Mycetophyllia lamarckiana	≥ 10 cm	Yes	n/a
Scolymia spp.	≥ 10 cm	Yes	n/a
Siderastrea siderea	≥ 10 cm	Yes	n/a
Solenastrea bournoni	≥ 10 cm	Yes	n/a
Solenastrea hyades	≥ 10 cm	Yes	n/a
Stephanocoenia intersepta	≥ 10 cm	Yes	n/a
Agaricia agaricites	≥ 10 cm	Yes	n/a
Porites astreoides	≥ 10 cm	Yes	n/a
Siderastrea radians	≥ 10 cm	Yes	n/a
Eunicea sp.		Yes	n/a
Muricea sp.		Yes	n/a
Plexaura sp.		Yes	n/a
Plexaurella sp.		Yes	n/a
Pterogorgia sp.		Yes	n/a

Budget	Item
Salaries	
	Program Director
	Field Project Manager/Senior Scientist
	Ops Coordinator
	Senior Field Tech
	Senior Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Labor Costs Assume Fully Loaded FTE's or Contractors
Travel/Supplies/Equipment	
	Supplies
	Field Equipment
	Travel
	IT Resources
	Vehicles Lease
	Acquisition and Replacement of 2-3 Vessels
	Vessel Scheduled and Anticipated Maintenance
	Dockage
	Office
	Storage
	Fuel
	Total
	Risk Mitigation
	Option 1 - USACE Maintains Risk for Project Failure and Cost Ove
	Option 2 - Project includes funds to rebuild from a catastrophic loss

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
$145,000	$150,075	$155,328	$160,764	$166,391	$172,215
$115,000	$119,025	$123,191	$127,503	$131,965	$136,584
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$100,000	$20,000	$21,000	$22,050	$50,000	$25,000
$35,000	$36,750	$38,588	$40,517	$42,543	$44,670
$35,000	$15,000	$15,750	$16,538	$40,000	$18,000
$14,500	$15,225	$15,986	$16,786	$17,625	$18,506
$650,000					
$10,000	$10,350	$10,712	$11,087	$11,475	$11,877
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$40,000	$41,400	$42,849	$44,349	$45,901	$47,507
$10,000	$10,350	$10,712	$11,087	$11,475	$11,877
$50,000	$51,750	$53,561	$55,436	$57,376	$59,384
$1,689,500	$920,150	$953,660	$988,408	$1,073,924	$1,062,263

rruns

; (major hurricane) that occurs prior to the completion of the project. Cost is calculated assuming that years 1-3 (p

Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
$178,242	$184,480	$190,937	$197,620	$204,537	$211,696
$141,364	$146,312	$151,433	$156,733	$162,219	$167,897
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$26,250	$27,563	$28,941	$100,000	$35,000	$36,750
$46,903	$49,249	$51,711	$54,296	$57,011	$59,862
$18,900	$19,845	$20,837	$45,000	$23,000	$24,150
$19,431	$20,403	$21,423	$22,494	$23,619	$24,800
			$850,000		
$12,293	$12,723	$13,168	$13,629	$14,106	$14,600
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$49,170	$50,891	$52,672	$54,516	$56,424	$58,399
$12,293	$12,723	$13,168	$13,629	$14,106	$14,600
$61,463	$63,614	$65,840	$68,145	$70,530	$72,998
$1,101,035	$1,141,244	$1,182,943	$2,168,923	$1,274,162	$1,320,837

›roject build out years) need to be repeated in order to get the project back on track and that Year 1

Year 13	Year 14	Year 15	Year 16	Year 17	Year 18
$219,105	$226,774	$234,711	$242,926	$251,428	$260,228
$173,773	$179,855	$186,150	$192,665	$199,408	$206,388
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$38,588	$40,517	$70,000	$44,000	$46,200	$48,510
$62,855	$65,998	$69,298	$72,762	$76,401	$80,221
$25,358	$26,625	$50,000	$29,000	$30,450	$31,973
$26,040	$27,342	$28,709	$30,144	$31,652	$33,234
$15,111	$15,640	$16,187	$16,753	$17,340	$17,947
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$60,443	$62,558	$64,748	$67,014	$69,359	$71,787
$15,111	$15,640	$16,187	$16,753	$17,340	$17,947
$75,553	$78,198	$80,935	$83,767	$86,699	$89,734
$1,369,250	$1,419,467	$1,521,056	$1,524,563	$1,580,561	$1,638,651

8, 19, & 20 actually occur in Year 21, 22, & 23 and therefore are approrpatiely inflation adjusted.

Year 19	Year 20	
$269,336	$278,763	$4,100,554
$213,611	$221,088	$3,252,163
$139,312	$144,188	$2,120,976
$139,312	$144,188	$2,120,976
$139,312	$144,188	$2,120,976
$102,162	$105,738	$1,555,382
$102,162	$105,738	$1,555,382
$102,162	$105,738	$1,555,382
$102,162	$105,738	$1,555,382
$37,150	$38,450	$565,594
$50,936	$53,482	$884,785
$84,232	$88,443	$1,157,308
$33,571	$35,250	$554,246
$34,896	$36,641	$479,456
		$1,500,000
$18,575	$19,225	$282,797
$37,150	$38,450	$565,594
$74,300	$76,900	$1,131,187
$18,575	$19,225	$282,797
$92,874	$96,125	$1,413,984
$1,698,913	$1,761,430	#########

Budget	Item
Salaries	
	Program Director
	Field Project Manager/Senior Scientist
	Ops Coordinator
	Senior Field Tech
	Senior Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Labor Costs Assume Fully Loaded FTE's or Contractors
Travel/Supplies/Equipment	
	Supplies
	Field Equipment
	Travel
	IT Resources
	Vehicles Lease
	Acquisition and Replacement of 2-3 Vessels
	Vessel Scheduled and Anticipated Maintenance
	Dockage
	Office
	Storage
	Fuel
	Total
	Risk Mitigation
	Option 1 - USACE Maintains Risk for Project Failure and Cost Ove
	Option 2 - Project includes funds to rebuild from a catastrophic loss

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
$145,000	$150,075	$155,328	$160,764	$166,391	$172,215
$115,000	$119,025	$123,191	$127,503	$131,965	$136,584
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$30,000	$31,050	$32,137	$33,262	$34,426	$35,631
$250,000	$20,000	$21,000	$22,050	$50,000	$25,000
$35,000	$36,750	$38,588	$40,517	$42,543	$44,670
$35,000	$15,000	$15,750	$16,538	$40,000	$18,000
$14,500	$15,225	$15,986	$16,786	$17,625	$18,506
$750,000					
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$25,000	$25,875	$26,781	$27,718	$28,688	$29,692
$40,000	$41,400	$42,849	$44,349	$45,901	$47,507
$15,000	$15,525	$16,068	$16,631	$17,213	$17,815
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$2,119,500	$1,096,100	$1,135,768	$1,176,890	$1,269,002	$1,264,170

rruns

; (major hurricane) that occurs prior to the completion of the project. Cost is calculated assuming that years 1-3 (p

Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
$178,242	$184,480	$190,937	$197,620	$204,537	$211,696
$141,364	$146,312	$151,433	$156,733	$162,219	$167,897
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$36,878	$38,168	$39,504	$40,887	$42,318	$43,799
$26,250	$27,563	$28,941	$250,000	$35,000	$36,750
$46,903	$49,249	$51,711	$54,296	$57,011	$59,862
$18,900	$19,845	$20,837	$45,000	$23,000	$24,150
$19,431	$20,403	$21,423	$22,494	$23,619	$24,800
			$950,000		
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$30,731	$31,807	$32,920	$34,072	$35,265	$36,499
$49,170	$50,891	$52,672	$54,516	$56,424	$58,399
$18,439	$19,084	$19,752	$20,443	$21,159	$21,900
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$1,310,009	$1,357,531	$1,406,801	$2,650,616	$1,513,964	$1,569,032

ıroject build out years) need to be repeated in order to get the project back on track and that Year 1

Year 13	Year 14	Year 15	Year 16	Year 17	Year 18
$219,105	$226,774	$234,711	$242,926	$251,428	$260,228
$173,773	$179,855	$186,150	$192,665	$199,408	$206,388
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$45,332	$46,919	$48,561	$50,260	$52,020	$53,840
$38,588	$40,517	$70,000	$44,000	$46,200	$48,510
$62,855	$65,998	$69,298	$72,762	$76,401	$80,221
$25,358	$26,625	$50,000	$29,000	$30,450	$31,973
$26,040	$27,342	$28,709	$30,144	$31,652	$33,234
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$37,777	$39,099	$40,467	$41,884	$43,350	$44,867
$60,443	$62,558	$64,748	$67,014	$69,359	$71,787
$22,666	$23,459	$24,280	$25,130	$26,010	$26,920
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$1,626,132	$1,685,339	$1,796,234	$1,809,372	$1,875,339	$1,943,746

8, 19, & 20 actually occur in Year 21, 22, & 23 and therefore are approrpatiely inflation adjusted.

Year 19	Year 20	
$269,336	$278,763	$4,100,554
$213,611	$221,088	$3,252,163
$139,312	$144,188	$2,120,976
$139,312	$144,188	$2,120,976
$139,312	$144,188	$2,120,976
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$111,449	$115,350	$1,696,781
$111,449	$115,350	$1,696,781
$111,449	$115,350	$1,696,781
$111,449	$115,350	$1,696,781
$111,449	$115,350	$1,696,781
$55,725	$57,675	$848,390
$50,936	$53,482	$1,184,785
$84,232	$88,443	$1,157,308
$33,571	$35,250	$554,246
$34,896	$36,641	$479,456
		$1,700,000
$37,150	$38,450	$565,594
$46,437	$48,063	$706,992
$74,300	$76,900	$1,131,187
$27,862	$28,838	$424,195
$111,449	$115,350	$1,696,781
$2,014,686	$2,088,255	########

Budget	**Item**
Salaries	
	Program Director
	Field Project Manager/Senior Scientist
	Ops Coordinator
	Senior Field Tech
	Senior Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Labor Costs Assume Fully Loaded FTE's or Contractors
Travel/Supplies/Equipment	
	Supplies
	Field Equipment
	Travel
	IT Resources
	Vehicles Lease
	Acquisition and Replacement of 2-3 Vessels
	Vessel Scheduled and Anticipated Maintenance
	Dockage
	Office
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$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$100,000	$20,000	$21,000	$22,050	$50,000	$25,000
$35,000	$36,750	$38,588	$40,517	$42,543	$44,670
$35,000	$15,000	$15,750	$16,538	$40,000	$18,000
$14,500	$15,225	$15,986	$16,786	$17,625	$18,506
$650,000					
$10,000	$10,350	$10,712	$11,087	$11,475	$11,877
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$40,000	$41,400	$42,849	$44,349	$45,901	$47,507
$10,000	$10,350	$10,712	$11,087	$11,475	$11,877
$50,000	$51,750	$53,561	$55,436	$57,376	$59,384
$1,689,500	$920,150	$953,660	$988,408	$1,073,924	$1,062,263

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; (major hurricane) that occurs prior to the completion of the project. Cost is calculated assuming that years 1-3 (p

Year 7	Storm Year	Recovery Year 1	Recovery Year 2	Year 8	Year 9
$178,242	$184,480	$190,937	$197,620	$204,537	$211,696
$141,364	$146,312	$151,433	$156,733	$162,219	$167,897
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$25,875	$103,500	$27,000	$27,945	$28,923	$30,369
$46,233	$47,851	$49,526	$51,260	$53,054	$55,706
$18,630	$36,000	$19,000	$19,665	$20,353	$21,371
$19,154	$19,824	$20,518	$21,236	$21,979	$23,078
	$850,000				
$12,293	$12,723	$13,168	$13,629	$14,106	$14,600
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$49,170	$50,891	$52,672	$54,516	$56,424	$58,399
$12,293	$12,723	$13,168	$13,629	$14,106	$14,600
$61,463	$63,614	$65,840	$68,145	$70,530	$72,998
$1,099,443	$2,081,360	$1,176,076	$1,217,238	$1,259,842	$1,305,801

ıroject build out years) need to be repeated in order to get the project back on track and that Year 1

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
$219,105	$226,774	$234,711	$242,926	$251,428	$260,228
$173,773	$179,855	$186,150	$192,665	$199,408	$206,388
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$100,000	$35,000	$36,750	$38,588	$40,517	$70,000
$58,492	$61,416	$64,487	$67,712	$71,097	$74,652
$45,000	$23,000	$24,150	$25,358	$26,625	$50,000
$24,232	$25,444	$26,716	$28,052	$29,455	$30,927
$1,000,000					
$15,111	$15,640	$16,187	$16,753	$17,340	$17,947
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$60,443	$62,558	$64,748	$67,014	$69,359	$71,787
$15,111	$15,640	$16,187	$16,753	$17,340	$17,947
$75,553	$78,198	$80,935	$83,767	$86,699	$89,734
$2,444,134	$1,403,845	$1,455,152	$1,508,364	$1,563,553	$1,670,293

8, 19, & 20 actually occur in Year 21, 22, & 23 and therefore are approrpatiely inflation adjusted.

Year 16	Year 17	Year 18	Year 19	Year 20	
$269,336	$278,763	$288,519	$298,618	$309,069	$4,996,760
$213,611	$221,088	$228,826	$236,835	$245,124	$3,962,948
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$102,162	$105,738	$109,438	$113,269	$117,233	$1,895,323
$102,162	$105,738	$109,438	$113,269	$117,233	$1,895,323
$102,162	$105,738	$109,438	$113,269	$117,233	$1,895,323
$102,162	$105,738	$109,438	$113,269	$117,233	$1,895,323
$37,150	$38,450	$39,796	$41,189	$42,630	$689,208
$44,000	$46,200	$48,510	$50,936	$53,482	$1,045,644
$78,385	$82,304	$86,419	$90,740	$95,277	$1,372,678
$29,000	$30,450	$31,973	$33,571	$35,250	$629,683
$32,474	$34,097	$35,802	$37,592	$39,472	$568,681
					$2,500,000
$18,575	$19,225	$19,898	$20,594	$21,315	$344,604
$37,150	$38,450	$39,796	$41,189	$42,630	$689,208
$74,300	$76,900	$79,592	$82,377	$85,260	$1,378,417
$18,575	$19,225	$19,898	$20,594	$21,315	$344,604
$92,874	$96,125	$99,489	$102,972	$106,576	$1,723,021
$1,679,137	$1,740,665	$1,804,484	$1,870,681	$1,939,348	########

Budget	**Item**
Salaries	
	Program Director
	Field Project Manager/Senior Scientist
	Ops Coordinator
	Senior Field Tech
	Senior Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Labor Costs Assume Fully Loaded FTE's or Contractors
Travel/Supplies/Equipment	
	Supplies
	Equipment
	Travel
	IT Resources
	Vehicles Lease
	Acquisition and Replacement of 2-3 Vessels
	Vessel Scheduled and Anticipated Maintenance
	Dockage
	Office
	Storage
	Fuel
	Total
	Risk Mitigation
	Option 1 - USACE Maintains Risk for Project Failure and Cost Ove
	Option 2 - Project includes funds to rebuild from a catastrophic los

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
$145,000	$150,075	$155,328	$160,764	$166,391	$172,215
$115,000	$119,025	$123,191	$127,503	$131,965	$136,584
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$30,000	$31,050	$32,137	$33,262	$34,426	$35,631
$250,000	$20,000	$21,000	$22,050	$100,000	$25,000
$35,000	$36,750	$38,588	$40,517	$42,543	$44,670
$35,000	$15,000	$15,750	$16,538	$40,000	$18,000
$14,500	$15,225	$15,986	$16,786	$17,625	$18,506
$750,000					
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$25,000	$25,875	$26,781	$27,718	$28,688	$29,692
$40,000	$41,400	$42,849	$44,349	$45,901	$47,507
$15,000	$15,525	$16,068	$16,631	$17,213	$17,815
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$2,119,500	$1,096,100	$1,135,768	$1,176,890	$1,319,002	$1,264,170

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; (major hurricane) that occurs prior to the completion of the project. Cost is calculated assuming that years 1-3 (p

Year 7	Storm Year	Recovery Year 1	Recovery Year 2	Year 8	Year 9
$178,242	$184,480	$190,937	$197,620	$204,537	$211,696
$141,364	$146,312	$151,433	$156,733	$162,219	$167,897
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$36,878	$38,168	$39,504	$40,887	$42,318	$43,799
$25,875	$255,000	$27,000	$27,945	$28,923	$30,369
$46,233	$47,851	$49,526	$51,260	$53,054	$55,706
$18,630	$36,000	$19,000	$19,665	$20,353	$21,371
$19,154	$19,824	$20,518	$21,236	$21,979	$23,078
	$850,000				
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$30,731	$31,807	$32,920	$34,072	$35,265	$36,499
$49,170	$50,891	$52,672	$54,516	$56,424	$58,399
$18,439	$19,084	$19,752	$20,443	$21,159	$21,900
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$1,308,416	$2,449,148	$1,399,933	$1,448,931	$1,499,643	$1,553,995

roject build out years) need to be repeated in order to get the project back on track and that Year 1

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
$219,105	$226,774	$234,711	$242,926	$251,428	$260,228
$173,773	$179,855	$186,150	$192,665	$199,408	$206,388
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$45,332	$46,919	$48,561	$50,260	$52,020	$53,840
$250,000	$35,000	$36,750	$38,588	$40,517	$70,000
$58,492	$61,416	$64,487	$67,712	$71,097	$74,652
$45,000	$23,000	$24,150	$25,358	$26,625	$50,000
$24,232	$25,444	$26,716	$28,052	$29,455	$30,927
$950,000					
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$37,777	$39,099	$40,467	$41,884	$43,350	$44,867
$60,443	$62,558	$64,748	$67,014	$69,359	$71,787
$22,666	$23,459	$24,280	$25,130	$26,010	$26,920
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$2,801,016	$1,669,717	$1,730,330	$1,793,174	$1,858,330	$1,975,388

8, 19, & 20 actually occur in Year 21, 22, & 23 and therefore are approrpatiely inflation adjusted.

Year 16	Year 17	Year 18	Year 19	Year 20	
$269,336	$278,763	$288,519	$298,618	$309,069	$4,996,760
$213,611	$221,088	$228,826	$236,835	$245,124	$3,962,948
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$55,725	$57,675	$59,694	$61,783	$63,945	$1,033,812
$44,000	$46,200	$48,510	$50,936	$53,482	$1,547,144
$78,385	$82,304	$86,419	$90,740	$95,277	$1,372,678
$29,000	$30,450	$31,973	$33,571	$35,250	$629,683
$32,474	$34,097	$35,802	$37,592	$39,472	$568,681
					$2,550,000
$37,150	$38,450	$39,796	$41,189	$42,630	$689,208
$46,437	$48,063	$49,745	$51,486	$53,288	$861,510
$74,300	$76,900	$79,592	$82,377	$85,260	$1,378,417
$27,862	$28,838	$29,847	$30,891	$31,973	$516,906
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$1,994,910	$2,067,490	$2,142,748	$2,220,785	$2,301,705	#########

NMFS Responses to Questions Raised by Jason Spinning

US Army Corps of Engineers, Jacksonville District

June 7, 2013

Overall comment: To minimize confusion, recommend NMFS and COE we adopt a common terminology:

- Transplant = relocate off natural reef as a minimization measure
- Outplant = relocate propagated corals from nursery to reef

1. Please explain the cost of the proposed mitigation and how it would be spread over the 20 years. Understanding that the potential funding may not be provided until the project is Authorized, Appropriated, Permitted, and the Contract Awarded. Timeframe cannot be determined. First major step is completion of a policy compliance Feasibility Study and Chief's Report awaiting a Water Resources Development Act (WRDA) bill signed. Last one was 2007 and before that 2000.

- A draft budget spreadsheet is attached.

2. What would be the final location for transplantation? This goes to the potential of compensating for the impacts at the project footprint.

- In this response, we assume that when Jason uses the term *transplantation*, he is asking about the outplants from the nursery (versus corals relocated outside of the project area as minimization). Generally outplanting will occur on reef located offshore Broward County. Identifying the exact locations for ouplanting will not be problematic, but is not appropriate to do at this point in time. Outplant site selection will be determined based on a strategy designed and included in the NOAA active propagation plan that is currently being developed. Therefore there is no risk that there will not be appropriate sites available for outplanting. Current and anticipated regulatory mechanisms and conservation priorities will also increase the feasibility of identifying suitable outplanting efforts.

3. How would the proposed coral propagation mitigation alternative compensate for the impacts generated by the project? Written statement?

- This mitigation alternative has the capability to replace coral ecosystem functions lost as a result of expansion at Port Everglades. Additionally, the coral propagation program will allow for the type of larval transport, settling and colonization into new areas, and genetic mixing required for survival and recovery of the species. NOAA's recommendation is based on careful evaluation of the expected losses of live scleractinian coral and octocorals from the expansion of the port's Outer Entrance Channel and the successes of coral propagation and enhancement programs in Atlantic and Caribbean waters. This proposal is based on utilizing existing NOAA programs and experience to manage the implementation of the project in conjunction with local resource agencies and universities. The success of past active population enhancement and coral propagation efforts, combined with the potential for this option to considerably contribute to improved southeast Florida coral reef ecosystem health and protected resources conservation, identifies coral propagation and species enhancement as NOAA preferred option for coral reef mitigation.

The project will increase production of propagated corals, help rebuild populations of this threatened species, restore coral reefs, improve ecosystem services, and invest in the infrastructure needed for future restoration activities. When coupled with advanced genetics, nursery-reared corals with high survivorship potential (typically 1 year or more in age) can be outplanted to adjacent degraded reefs to enhance the genetic diversity and population size of remnant coral populations. These supplemented corals will improve local reef structure and function but more importantly they directly contribute to the pool of coral larvae available to adjacent reefs during normal coral spawning periods. It is estimated that a coral reef that is seeded with just 35 nursery-raised *Acropora* colonies per year can recover to 1970's levels of coral cover within 10 years. Natural rates of recovery would require several decades under best case scenarios. By building on the success of the previous restoration work in South Florida, we will be able to restore corals to reefs that have been chronically degraded by bleaching, disease, hurricanes, coastal development and destructive fishing gear, as well as reefs acutely damaged by ship grounding and anchor damage.

Coral restoration techniques have the potential to reverse the population decline and accelerate the re-growth of a reef after disturbances. Based on current models from Center for Marine Biodiversity and Conservation and NOAA, under ideal conditions with no action it will take at least 300 years for the Acropora population to recover to historic norms. However, with large-scale active restoration, this time frame could be notably reduced. By increasing population numbers through restoration of genetically diverse transplanted fragments, the likelihood of successful cross-fertilization between these corals is increased. This will help acroporid corals overcome the Allee effect, where reproduction and survival of individuals decrease in smaller populations and increase recruitment rates within both regions.

4. We may be looking at a combination of alternatives or even components of each alternative as the overall solution. What is the proposed structural component for the transplantation understanding that beneficial use of dredged rock may not be appropriate due to material size? What about using known grounding locations for transplantation or relocation in combo?

- In this response, we assume that when Jason uses the term *transplantation*, he refers to the corals relocated from natural reef as minimization and *relocation* refers to corals outplanted from a nursery. We recommend the EIS include all options for these corals including natural reef, artificial reef material, and known grounding locations that have been meet minimum requirements that we could jointly develop – for example, suitable grounding sites include those that have had rubble stabilized. FDEP Coral Reef Conservation Program maintains a list of known orphaned grounding sites. Per a phone conversation on June 6, 2013, with the FDEP CRCP Regional Administrator, Joanna Walczak, FDEP believes nursery reared corals will be needed for planned restoration activities at these sites. Using a combination of transplanted and outplanted corals at the same restoration site would require careful planning to ensure that performance criteria could be measured. The EIS could list the components in tabular form and then ask the public which of these elements, or if all of these elements are needed in the mitigation plan. If possible, flexibility should be maintained for the resource managers to determine the exact mix of site types and site locations until closer to actual project implementation.

5. Since there is no Acropora within the project footprint but the site is within CH, what is the reasonable assurance that the propagation and transplantation would be successful?

- While *Acropora* spp. have not yet been documented to occur directly within the project site, the species do occur near the site and throughout the waters of Broward County, in varying densities. Further, as designated critical habitat, it is NMSF's judgment that the area (i.e., impacted reef and reefs throughout Broward County) could support recruitment and growth of the species. This has proven true through the successful implementation of nursery and outplanting operations in Broward County.

  For example, the NOAA proposal builds on the success of the previous restoration work in South Florida. Coral propagation projects were started in 2000 by the Coral Restoration Foundation (CRF) in the Keys in 2000. In 2004, The Nature Conservancy (TNC) and Coral Restoration Foundation (CRF) initiated a Staghorn Coral Restoration Project funded through the National Partnership between NOAA Community-Based Restoration Program and The Nature Conservancy (NOAA/TNC CRP). All outplanting has been monitored to evaluate survivorship and growth rates as related to coral genotype. Results and lessons learned from this pilot project have been integrated into the NOAA proposal to ensure the practices are followed that yield the highest growth and survivorship rates.

  In August 2006, additional funding was received through the NOAA/TNC CRP to expand the Upper Keys restoration efforts and replicate the restoration approach in three more sub-regions of the Florida Reef Tract (i.e. Lower Keys, Biscayne, and Broward). In each sub-region a new nursery site was established by a new project partner (i.e. Mote Marine Laboratory, University of Miami, and Nova Southeastern University respectively) which coordinated permitting and field work with local resource management agencies (i.e. FKNMS, Biscayne National Park [BNP], Broward County Department of Environmental Protection respectively). This expanded project allow comparisons between genotypic fitness in staghorn coral across much of the Florida Reef Tract. Evaluation of sub-regional and zonal variation in survivorship and growth established a solid basis for siting larger-scale restoration efforts to provide the greatest returns in restoration success and corresponding improvements in goods and services.

By building on the success of the previous restoration work in South Florida, and partnering with the local academic and coral reef management agencies we will be able to replicate success and restore corals to reefs that have been degraded by a myriad of issues that may include coastal development, bleaching, disease, hurricanes, and/or reefs acutely damaged by ship grounding and anchor damage.

6. All Acropora and corals >5cm, again what is the likelihood for success for these individuals at this small size?

- In calculating impacts, we generously estimated that 90% of the corals are relocated and 85% survive relocation after three years. The likelihood of success is high. Corals greater than or equal to 5 centimeters in diameter can be successfully relocated. Brownlee (2010) successfully transplanted small coral (*Siderastrea siderea, Dichocoenia stokesii,* and *Porites porites*) with greater than 80 percent survivorship after 13 months. Monty et al. (2006) successfully transplanted 250 corals (14 species) ranging from 5 to 40 centimeters in diameter with a high rate of survivorship. These corals were monitored for 13 months. Eight species had 100 percent survivorship, including 78 *Siderastrea siderea.* Thornton et al. (2000) transplanted 271 corals from an outfall pipe in Broward County to an articulated concrete mat. *Siderastrea siderea* comprised 90 percent of the corals <1 to 100 square centimeters in size. After 27 months, 266 of the corals had survived (87 percent), as compared to 83 percent survival for corals on the nearby natural substrate. In addition, Stephens (2007) salvaged from a coastal construction impact site in Broward County and 92 to 100% of the transplants survived after 18 to 24 months.

7. Contingency planning, the Corps does not have the capability for the extra funding (risk) if the propagation efforts fail. Management would be against being on the hook if NOAA efforts or other entity efforts would not be successful. They view this as a mitigation banking type arrangement where the money for the work would be provided and then we would walk away. If this is a component of the mitigation plan then the Corps will need to limit liability for overall success of this effort and to ensure there is not a cost risk above normal contingencies.

- We understand this and that is why we are willing to include the contingency funds as part of the project. Based on this feedback, we can revise the overall cost to include contingency and drop the discussion of risk having multiple options. This is reflected as "Option 2" in the attached budget.

Literature Cited:

Brownlee A.S. 2010. Transplantation and parrotfish predation: A study on small *Siderastrea sidereal* offshore Broward County, FL USA. Master's Thesis. NOVA Southeastern University Oceanographic Center.

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APPENDIX E-6

Mitigation, Monitoring and Adaptive Management Plan

waPORT EVERGLADES EXPANSION MONITORING AND ADAPTIVE MANAGEMENT PLAN U.S. ARMY CORPS OF ENGINEERS (USACE) and NATIONAL MARINE FISHERIES SERVICE (NMFS)

All monitoring, associated reporting and adaptive management for the seagrass and mangrove mitigation at West Lake Park shall be performed by the Broward County Parks Department or their contractors as required under Department of Army Permit Number #2002-00072. Those requirements are incorporated by reference.

The Construction portion of this plan is based on the Monitoring Plan developed for the Miami Harbor Expansion Project as part of the Florida Department of Protection Permit # 0305721-001-BI issued May 22, 2012. It may be updated based on the lessons learned from and results of the Miami Harbor expansion project which began construction in Fall 2013.

Pre-, During and Post-Construction Monitoring

MONITORING IN THE AREA OF HARDBOTTOM COMMUNITIES AND CORAL REEFS:
The proposed monitoring of the Port Everglades Channel deepening and widening project includes monitoring for direct and indirect impacts to hardbottom and coral reef communities in the project area and adjacent areas. Monitoring activities shall include pre-, during, and post-construction surveys of hardbottom and coral reef communities.

Monitoring Stations
Stations will be established within each habitat type identified in the Benthic and Fish Community Assessment at Port Everglades Harbor Entrance Channel, hereafter referred to as the "Benthic Assessment" (DCA, 2009), adjacent to of the Entrance channel to evaluate potential construction and sediment impacts as well as evaluate any long-term impacts to the benthic assemblages. An example of these stations is presented in Figure 1. Three 20-m transects will be established 10 meters from the channel edge in a north-south direction, at each hard bottom habitat type station identified in the Benthic Assessment (R3N-1; R3N-2; R3N-3; R3S-1; R3S-2; R3S-3; R2N-1; R2N-2; R2S-1; R2S-2; HBN-1; HBN-2; HBS-1; HBS-2 for a total of 14 stations and 42 transects, 20 meters long by 40 cm (0.40 meters) wide equaling 336 m^2 of project area being directly monitored. Additionally, 12 control sites with three transects per site (36 transects) in analogous habitat areas of equal length and width for a total of 288m^2 will also be established and monitored to detect natural variation in the resources and to assist in determining the effects of the actual dredge operations on the resources surrounding the project area.

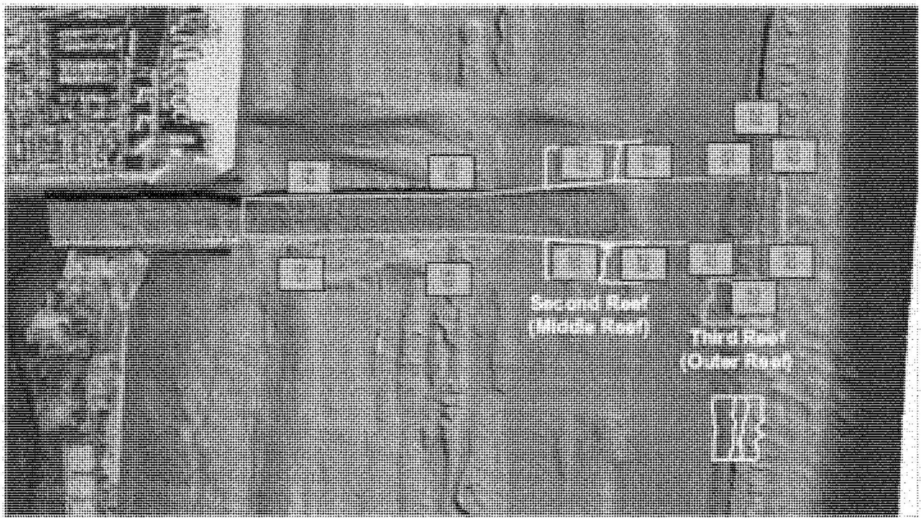

Figure 1 - Monitoring Station Locations

Transects will be located within hard bottom/reef resources adjacent to the project area and within comparable reference areas previously identified in the Baseline Report. Individual station transects will be at least 5 m apart within each habitat type. They will be randomly positioned within areas that include coral colonies and other attached fauna within each specific resource type. Stainless steel eyebolts (3/8-in. by 8-in.) will be drilled and epoxied into the bottom at 0, 10, and 20 meters along each transect at the hard bottom and reef sites. A small closed-cell foam float coated with anti-fouling paint will be attached to each eyebolt with a short length of nylon braided line to aid in transect relocation. All transect marker eyebolts and buoys will be removed following completion of the monitoring program. Vertical-format quantitative digital video data will be collected along each transect with the camera positioned 40 cm above and perpendicular to the substrate. This will yield an approximately 40-cm wide video field-of-view. The video camera will be equipped with lights and a measuring stick or calibrated lasers to ensure the camera remains at the 40-cm distance to the bottom. The diver will swim the camera along each transect at a speed of no greater than approximately 5-meters per minute. This method will be used to evaluate both the coral health and potential sedimentation stress during construction at both the dredge location site and the control monitoring station sites as further described below:

Quality Assurance/Quality Control (QA/QC) and Safety. Qualified marine biologists trained in conducting hardbottom and seagrass monitoring surveys shall conduct this work (minimum qualification of BS in marine biology). Inter-observer variability exists through the level of detail as defined by each marine biologist when utilizing similar survey methods, particularly in methods of rapid assessment that will used for this survey. Therefore, additional QA/QC measures will include the collection of a sample data set by each marine biologist in two transects of the initial set of transects. This QA/QC test will be conducted **prior** to collecting project-specific data (i.e., before commencement of dredging). The initial QA/QC exercise shall observe swimming technique and measurement collection along the transect line. The sediment depth measurements of each surveying crew member shall be compared to one another and statistically treated. The results of the sample data set shall be reviewed by the team to ensure consistency in species identification, percent cover (not more than 10% deviation), sediment thickness (not more than 5mm average difference), and/or the level of detail of organisms observed. Variability of $\geq$10% and/or unidentified organisms may require the collection of a second sample data set, to be determined onsite by the team leader.

Prior to entering the data into a project-specific Microsoft Access database, the field forms will receive a final review for completeness and accuracy. The database will be used to manage the data collected during the monitoring events. This form of database management incorporates quality control during the data entry process through standardized formatting and summation of functional groups. Data review and interpretation shall be a permanent process of comparison of repeatable surveys. The comparison will be conducted by individual transect (i.e., what is the change in each individual transect), and then by the entire set of transects on one side of the channel, and finally, a comparison of the changes documented on one side of the channel to those documented on the other side.

The contractor's diving operations shall comply with all the requirements of Section 30 of the U.S. Army Corps of Engineers "Safety and Health Requirements Manual", EM 385-1-1 (3 September 1996); and "Contract Diving Operations", to Jacksonville District Regulation CESAJR 385-1-1 (1 September 1998); or any subsequent updated manuals. A diving operations plan and the other submittal items specified below must be reviewed and accepted by USACE District Diving Coordinator and the Safety Office prior to the commencement of diving operations. If not specifically stated in the referenced documents above, then a "small craft advisory" would be considered the basis for conducting dive operations; whereby no diving would be conducted under such adverse weather conditions.

BIOLOGICAL MONITORING DURING CONSTRUCTION

Construction Period Surveys for Coral Health

1) Construction surveys will be conducted at each transect by the Contractor within each monitoring station by qualified marine biologists and involve:
    a. Evaluating benthic organisms (scleractinian corals, octocorals, sponges, etc.) for standing sediment that is not removed by normal currents or wave action.
    b. On each of the transects, a set of ten (10) stony coral colonies composed of at least four different species will be selected for monitoring. Ten colonies was chosen as the number of colonies to be monitored per station based upon baseline survey dives throughout the project area. Selected species may include Agaricia agaricites, *Colpophyllia natans, Dichocoenia stokesi, Diploria clivosa, Diploria strigosa, Montastrea annularis, Montastrea cavernosa, Porites astreoides, Siderastrea siderea, Solenastrea bournoni*, and *Stephanocoenia michelini.* Each colony will be healthy, greater than 10 cm in diameter, have a nearly horizontal orientation to the seafloor, and be marked with a numbered tag attached to a stainless steel pin drilled and epoxied into the bottom next to the colony. The position of each colony also will be mapped relative to the location of the net sediment accumulation block (distance and bearing) and recorded to allow relocation on subsequent surveys. Coral health assessment parameters will include bleaching, excess mucus production, polyp extension, and disease. Each selected coral colony will be assessed for each of the health parameters and assigned a health level of either "0" or "1" for each parameter. A score of "0" would indicate no observed bleaching, excess mucus production, polyp extension, or disease, while a "1" would be assigned for each parameter with a positive indication. The score for each parameter for each coral colony will be recorded, and the coral health observations will be documented with approximately 15 seconds of video per individual colony. A coral receiving a score of "1" for two or more parameters will be classified as declining in health. Additionally, if three or more corals at any project area site show evidence of either bleaching or disease during a survey, this will indicate declining health at the site. Each monitoring site will have a unique identification number that, along with date and time, will be recorded on videotape at the beginning of each site visit. Individual coral tag numbers also will be recorded on tape for each monitored colony at each site.

2) This data will be collected for each project area transect and each control area transect.
3) Reef conditions during construction surveys will also be documented through digital photographs and video. Photographs will include:
    a. Wide angle reef scenes (as visibility allows).

   b. Close-up photographs documenting organism experiencing potential sediment stress (i.e., burial, excess mucus, extruding polyps, color change).
   c. Video will be taken of each transect within each monitoring station 40 cm (0.4 meters) from the bottom, perpendicular to the transect, off the bottom.
4) Survey Frequency
   a. Before active dredging, the 14 monitoring stations located in the reef habitats along either side of the entrance channel, and the 12 corresponding reference sites, will be surveyed at least once a week for four (4) weeks to establish baseline conditions at the monitoring stations.
   b. For the duration of active dredging (construction), the reef habitats surrounding the entrance channel and the corresponding habitat reference sites will be surveyed twice a week at the monitoring stations within 750 meters of the dredging activities, and the corresponding reference sites, when dredging occurs within 750 meters of reef or hardbottom habitat.
   c. After active dredging, the 14 the monitoring stations located in the reef habitats surrounding the entrance channels and the 12 corresponding reference sites will be surveyed at least once a week for four (4) weeks.

Reporting –
1) A report will be submitted documenting the survey efforts prior to dredging. This report along with raw data will be submitted to the Contracting Officer (CO) within 15 days upon monitoring completion and provided to the agencies within 45 days of monitoring completion.
2) During active dredging, weekly reports will be submitted to the Corps via e-mail (or ftp site) describing survey results.
3) A report will be submitted after construction detailing the results for the four week post construction surveys. This report along with raw data will be submitted to the CO within 15 days upon monitoring completion and provided to the agencies within 45 days of monitoring completion.
4) The agencies will be notified of sediment stress by phone, fax, or e-mail, and followed by a written report to be submitted within 24 hours and will be notified immediately of the possibility of unacceptably high sediment levels on the reefs (or on the next work day if the indicators are noted on a weekend or holiday). If stress is recorded, the dredging operation may be required to move to a new location, at least 400 feet away, until effected organisms have recovered (signs of stress are no longer visible).

<u>Qualitative Construction Surveys for Indication of Sediment Impact and/or Stress</u>
These stations are the same stations from the construction monitoring stations of coral health, designed to monitor any environmental change or sedimentation impact and/or stress on biological organisms attributed to construction activities previously described. In addition to the construction monitoring, sediment monitoring shall be conducted as detailed below.

1) Construction surveys will be conducted by qualified marine biologists at the monitoring station transects.
2) Survey Frequency:
   a. Before active dredging, the reef habitat surrounding the entrance channel will be surveyed at least once a week for four (4) weeks to establish baseline conditions.
   b. For the duration of active dredging (construction), the reef habitat surrounding the entrance channel will be surveyed twice a week for reef areas adjacent to the channel that are within 750 meters from the dredging and overflow activities, only when dredging and overflow occurs within 750 meters of reef or hardbottom habitat.
   c. After active dredging, the reef habitat surrounding the entrance channels will be surveyed at least once a week for four (4) weeks.
3) Sediment stress will be defined as build-up of sediment significantly above the level found at the control or reference stations sufficient to cause any one or more of the following conditions:
   a. A frequency of observed bleaching (partial or complete) of scleractinian coral colonies.
   b. Excessive mucus produced by scleractinian corals to remove sediment from their surface, resulting in binding of sediments and transport of bound sediments off the coral's surface and subsequent accumulation of the sediments at the base of the coral head. Such accumulations

have been seen to initiate a "self burial" process, causing death of the lower tissue of the coral head.

c. Covering of benthic community components (i.e., sponge, algae) by sediment for sufficient time or sufficient sediment so as to note death or degradation (i.e., bleaching, pigmentation changes) of the underlying organisms.

4) Any change of 5% of more in cover any functional group evaluated in two or more adjacent transects, or on average for the zone of monitoring on one side of the channel, or stress expressed above normal by corals and/or
5) Impacted areas shall continue to be monitored monthly during construction and one month post-construction, in order to document results of the impact. The Contractor shall provide a plan for detecting this change utilizing standard coral reef coverage assessment methodologies and include this proposed methodology in the Request for Proposal package.
6) A stress violation shall require increasing the frequency of surveys and/or activities will be modified to reduce impacts, including potential relocation of dredging or overflow operations.

Reporting -

a. A report will be submitted documenting the survey efforts prior to dredging. This report along with raw data will be submitted to the CO within 90 days upon baseline, pre-dredging monitoring completion and provided to the agencies within 120 days of monitoring completion.
b. During active dredging, weekly reports will be submitted via e-mail (or web site) describing survey results.
c. A report will be submitted after construction detailing the results for the four week post construction surveys. This report along with raw data will be submitted to the CO within 120 days upon monitoring completion and provided to the agencies within 150 days of monitoring completion.
d. The agencies will be notified of sediment stress by within 24 hours of finalization of analysis indicating the possibility of unacceptably high sediment levels on the reefs. If stress is recorded, the dredging operation may be required to move to a new location, at least 400 feet away, until effected organisms have recovered (signs of stress are no longer visible).

Quantative Construction Sediment Monitoring

1) Sediment Traps:
   a. Arrays of three sediment traps will be placed at each of the hardbottom monitoring stations (including controls) to allow the comparison of net sediment accumulation block data with sediment trap data for a total of 26 sites. The sediment traps will be constructed of 1.0 in. inside diameter x 8 in. length polyvinyl chloride (PVC) pipe and a 500-ml nalgene collection jar, similar to the design being used in the Dade County and Broward County Shore Preservation Project monitoring programs. Both trap necks and jars will be coated with anti-fouling paint to minimize epibiotal growth. The PVC traps with the attached jar lids will be fastened to the steel sediment trap frame with hose clamps. The frame will be drilled and cemented into the bottom at hard bottom stations. Following completion of the monitoring program, all sediment traps, frames, and blocks will be removed.
   b. The traps will be positioned with the mouth of the trap no more than 18 in. above the bottom. Sediment traps will be changed at 28-day intervals by unscrewing the nalgene trap jars from the PVC collars and capping the jars. New jars then will be attached to the trap collars for the next collection interval. Sediment samples will be transported to the laboratory where the water and sediment will be filtered through labeled pre-weighed filters. The filters and sediments will be rinsed with fresh water to remove salts, and the filters containing the sediments then will be dried in an oven and weighed.

Reporting –

a. Raw data documenting the sedimentation deposition rates (traps) prior to dredging will be submitted to the CO within 30 days upon completion of the monitoring with a summary reported submitted within 45 days of completion.

b. During active dredging in the entrance channel, raw data from the sediment traps will be submitted to the CO within 30 days after lab analysis is completed with a summary report submitted within 45 days of completion. The report will be provided to the agencies after the CO has reviewed and accepted the report.
c. Raw data will be submitted after construction 30 days after last sampling event detailing the results for the four-week post construction surveys. A summary report will be submitted within 45 days of completion.

MONITORING ASSOCIATED WITH DREDGING OPERATIONS AND POTENTIAL IMPACTS

VESSEL TRANSIT MONITORING:
Due to the presence of hardbottom habitats and reefs adjacent to the channel, the Contractor shall stay within the marked entrance channel while in transit from the dredging area to/from the ODMDS. In coordination with the Contracting Officer's Representative (COR), the Contractor shall develop an ingress/egress pathway from the channel to the reef mitigation sites and shall record this as the only approved route to and from these sites aboard any vessels transiting to and from these sites. The Contractor shall contract the Florida Department of Environmental Protection's Coral Reef Conservation Program to obtain a copy of the GIS layers and benthic habitat maps. The FLDEP-CRCP contact is Ms. Lauren Waters at 305-795-1203 or via email: Lauren.Waters@dep.state.fl.us for instructions for how to obtain the files.

Hopper dredge and disposal tug/scow transit tracks will be recorded by the Contractor utilizing the Electronic Tracking System (ETS) and reviewed within 24 hours of the transit to the disposal site by the Contractor's environmental manager to ensure the vessel remained in the marked channel or approved corridor to the mitigation sites. If the dredge/tug & scow leaves the channel or approved corridor, the location will be marked and recorded in GIS, water depths of the location will be determined by reviewing existing surveys and, draft of the vessel will be determined by the ETS and the COR notified. If it is determined that the potential exists for an impact to have occurred as a result of the vessel leaving the channel or approved corridor, a survey team will be deployed by the Contractor within 24-hours (weather permitting) to assess any impact that may have occurred and conduct immediate remediation. If the team cannot be deployed within 24-hours, the Contractor shall report the delay to the COR and develop a deployment timeline. Remediation work (including re-attachment of scleractinian corals and octocorals) will be conducted immediately after the survey by the survey crew. Remediation activities should follow the FLDEP-SEFCRI "Rapid Response and Restoration for Coral Reef Injuries in Southeast Florida, Guidelines and Recommendations" dated June 2007 (DEP 2007). This report is available at:

http://www.dep.state.fl.us/coastal/programs/coral/reports/MICCI/MICCI_Project2_Guidelines.pdf

Any such survey and/or remediation efforts shall be at no additional cost to the Government.

Biological triage activities should occur as soon as possible following an injury. Fractured, dislodged, and overturned biological resources have a short window of opportunity in which they can be salvaged and stabilized. Therefore, the first step of biological triage is to right any overturned, dislodged, buried, or otherwise injured living organisms and mark them for repair. Often, it is possible to turn large corals right side up and they will remain stable temporarily without aid; however, small colonies and fragments can be easily overturned or washed off site by surge and wave energy. Small and fragmented stony coral, octocoral, and sponge colonies can be placed in baskets, milk crates, or other containers for temporary safekeeping.

Octocorals and sponges are more prone than other species to being moved by wave energy and surge, and thus need special care. Weighted baskets with lids are commonly used to secure them. These biological resources are vital to primary restoration and should be collected and cached in areas where they will be protected as much as possible from further injury while restoration activities are under way. Rubble should be stabilized or removed as soon as possible to prevent further injury to the site from rubble movement caused by rough seas or storms.

Prompt biological triage and primary restoration are especially critical during the hurricane and winter frontal storm seasons.

The non-remediated part of damage would be estimated and estimations will be included in the additional mitigation for project-related unanticipated damages. The results of damage survey will be provided to the CO immediately after the survey, and the report on the results of remediation and estimates of non-remediated damage will be provided to the CO within two weeks after the completion of remediation work. The CO or COR will coordinate with the appropriate resource agencies.

ANCHOR PLACEMENTS AND MONITORING

The Contractor shall limit dredge anchorage such that contact with and impacts to seagrasses and hardbottoms outside the channel is minimized/avoided to the maximum extent practicable. The approximate locations of these resources are shown in the contract drawings. If the contractor is required to anchor outside the channel to utilize a cutterhead dredge, anchor placement shall be placed to avoid affecting any of the habitat monitoring transects and sedimentation monitoring stations.

Coordinates of all dredge anchor drop points shall be recorded using DGPS technology, accurate to one (1) meter. Unauthorized impacts to seagrasses and hardbottoms shall require remediation and may be subject to further compensatory mitigation requirements. Divers shall visit all anchor locations that were positioned within the perimeter of a seagrass bed or hardbottom area both immediately after anchorage drop and within 2 days of the anchor being removed to investigate and record potential damage to hardbottoms. The contractor shall record all resources within the triangle created from the anchor point to the cable beginning location to the cable ending location. Specifically, the following information will be documented in each anchor triangle area before dredging commences: 1) scleractinian coral colonies, identified to species (maximum diameter measured in cm); 2) octocoral colonies, identified to genus (maximum diameter or height measured in cm, for upright colonies the maximum height would be measured and for flat or encrusting colonies, the maximum diameter would be measured); 3) sponge morphotypes (maximum diameter or height measured in cm); 4) zoanthids (maximum diameter measured in cm); and 5) macroalgae identified to the lowest taxonomic level. Occurrences of sea urchins, including *Diadema antillarum*, will be recorded by area. Rugosity data will be collected within each triangle, and calculated as (1–d/l), where d = the geometric distance of a transect measured using a weighted line and l = the length of the transect. The Florida Resilience Relief Program (FRRP) bleaching assessment protocol will be to characterize scleractinian colony condition. Video-transect data for all triangles will be collected for archival purposes, as previously discussed in the construction monitoring protocol.

After the area has been dredged, and the anchor is removed, the Contractor will resurvey the area, noting any impacts to resources, conducting remediation immediately, as appropriate, in accordance with FLDEP 2007 (previously referenced). Anchor damage to these resources shall be reported to the CO or COR within 48 hours of discovery of impact. A qualified marine biologist, as described above, shall certify these investigations.

Any non-remediated damage will be estimated and estimations will be included in the additional mitigation for project-related unanticipated damages. The results of damage survey will be provided to the resource agencies immediately after the survey, and the report on the results of remediation and estimates of non-remediated damage will be provided to the resource agencies within two weeks after the completion of remediation work.

DRAFT MONITORING

The draft of each disposal vessel shall be monitored via the Contractor's ETS and reviewed within 24 hours of the transit to the disposal site by the Contractor's environmental manager to ensure spillage or leakage has not occurred. If the data show a draft loss of more than one foot in depth from the loading site to the disposal site, the Contractor shall report the load number, scow number and draft loss to the CO or COR by email within 24-hours of the load disposal.

MONITORING OF IMPACTS ALONG CHANNEL WALLS WHERE CHANNEL WIDENING IS NOT PROPOSED.
Cross sectional surveys using multi-beam/side scan will be conducted and evaluated at 50-foot intervals within 30-days of completion of each acceptance section, to determine if dredging impacts occurred outside the channel limits and into existing habitat along the channel walls. If the cross sections indicate dredging outside the federally authorized footprint, additional evaluation will be conducted to determine the full extent of impacts and the impacts will be subject to compensatory mitigation based on established mitigation using the HEA methodology used to determine required compensatory mitigation for the project.

MONITORING OF IMPACTS BELOW DREDGE DEPTH IN THE CHANNEL FOOTPRINT
The Corps believes that up to 10% of the habitat below dredge depth may be incidentally impacted by rubble from the dredging during construction (depending on dredging methodologies), resulting in 100% loss of this portion of the habitat below dredge depth for the 50 year life of the project. To monitor the 10% the Corps believes will occur, and monitor for the additional potential 90% of the habitat, the Corps' contractor shall be required to conduct a high-resolution multi-beam survey (HRMB), coupled with a high resolution video survey with DGPS overlaid onto video feed - pre dredge survey of area below dredge depth in the channel downreef from direct impact site to establish a pre-construction baseline.

After the dredging is complete, the contractor shall perform a Post construction survey following the same methodology- redo surveys - overlay HRMB, and compare video side by side. The color and composition of the limestone rock should also the contractor to visually see if rock is "new rock" (bare, white limestone) or old rock already in the system (colonized by algae, etc). An assessment of the percent coverage of "white-bare" rock below dredge depth shall be made using the video and a report of the findings shall be submitted to the Corps to determine if additional mitigation is required.

PROTECTED MARINE SPECIES MONITORING DURING CONSTRUCTION AND BLASTING
The Contractor shall keep construction activities under surveillance, management, and control to minimize interference with, disturbance to, and damage of fish and wildlife. Species that require specific attention along with measures for their protection shall be listed in the Contractor's Environmental Protection Plan prior to the beginning of construction operation.

In the event that a threatened or endangered species is harmed as a result of construction activities, the Contractor shall cease all work and notify the Contracting Officer. The order of contact within the Corps of Engineers shall be as follows:

Order of Contact of Corps Personnel

Title	Telephone Number
Corps, Inspector	Onsite/After hours to be provided
Area Engineer, (CESAJ-CD-W)	561-472-3511
Chief, Environmental Branch Planning Division (CESAJ-PD-E)	904-232-1665
Chief, Construction Division (CESAJ-CD)	904-232-1118

Endangered Species Protection
The Contractor shall instruct all personnel associated with the project of the potential presence of manatees, sea turtles, dolphins and whales in the area, and the need to avoid collisions with and harming these animals. All construction personnel shall be advised that there are civil and criminal penalties for harming, harassing, or killing manatees, sea turtles, dolphins or whales which are protected under the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and/or the Florida Manatee Sanctuary Act. The Contractor shall be held responsible for any manatee, sea turtle, dolphin or whale harmed, harassed, or killed as a result of construction activities.

a. Siltation Barriers: If siltation barriers are used, they shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exit from essential habitat.

b. Special Operating Conditions:

(1) All vessels associated with the project shall operate at "no wake/idle" speeds at all times while in waters where the draft of the vessel provides less than a four-foot clearance from the bottom, and vessels shall follow routes of deep water whenever possible. Boats used to transport personnel shall be shallow-draft vessels, preferably of the light-displacement category, where navigational safety permits. Mooring bumpers shall be placed on all barges, tugs, and similar large vessels wherever and whenever there is a potential for manatees to be crushed between two moored vessels. The bumpers shall provide a minimum stand-off distance of four feet.

(2) If a manatee(s) or sea turtle(s) is sighted within 100 yards of the project area, all appropriate precautions shall be implemented by the Contractor to ensure protection of the manatee and/or sea turtle. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee or sea turtle. If a manatee or sea turtle is closer than 50 feet to moving equipment or the project area, the equipment shall be shut down and all construction activities shall cease within the down and all construction activities shall cease within the waterway to ensure protection of the manatee or sea turtle. Construction activities shall not resume until the manatee or sea turtle has departed the project area.

(3) If a turtle is taken by hopper dredge (dead or alive), a copy of the official incident take report shall be e-mailed in PDF format to takereport.nmfsser@noaa.gov and the Contracting Officer.

(4) Hopper Dredging operations shall cease if 3 turtles or 2 endangered turtles are taken until the Contracting Officer notifies the Contractor to resume dredging.

c. Manatee Monitoring (Clamshell Only): During clamshell dredging operations, a dedicated observer shall monitor for the presence of manatees. The dedicated observer shall have experience in manatee observation and be equipped with polarized sunglasses to aid in observing. Nighttime lighting of waters within and adjacent to the work area shall be illuminated, using shielded or low-pressure sodium-type lights, to a degree that allows the dedicated observer to see any manatee on the surface within 200 feet of the operation. The dredge operator shall gravity-release the clamshell bucket only at the water surface, and only after confirmation that there are no manatees within the safety distance identified in the standard construction conditions.

d. Manatee Signs: Prior to commencement of construction, each vessel involved in construction activities shall display at the vessel control station or in a prominent location, visible to all employees operating the vessel, a temporary sign at least 8-1/2" x 11" reading, "CAUTION: MANATEE HABITAT/IDLE SPEED IS REQUIRED IN CONSTRUCTION AREA." In the absence of a vessel, a temporary 3' x 4' sign reading "CAUTION: MANATEE AREA" shall be posted adjacent to the issued construction permit. A second temporary sign measuring 8-1/2" x 11" reading "CAUTION: MANATEE HABITAT. EQUIPMENT MUST BE SHUTDOWN IMMEDIATELY IF A MANATEE COMES WITHIN 50 FEET OF OPERATION" shall be posted at the dredge operator control station and at a location prominently adjacent to the issued construction permit. The Contractor shall remove the signs upon completion of construction.

Endangered Species Observers (Hopper Dredge Only)

During hopper dredging operations, Endangered Species Observers (ESO) approved by the National Oceanic and Atmospheric Administration - Fisheries (NOAA-Fisheries) for sea turtles and whales shall be aboard to monitor for the presence of the species. Observer coverage shall be 100 percent (24hr/day) and shall be conducted year round. During transit to and from the disposal area, the observer shall monitor from the bridge during daylight hours for the presence of endangered species, especially large whales. During dredging operations, while dragheads are submerged, the observer shall continuously monitor the inflow and/or overflow screening for turtles and/or turtle parts. Upon completion of each load cycle, dragheads should be monitored as the draghead is lifted from the sea surface and is placed on the saddle in order to assure that sea turtles that may be impinged within draghead are not lost and un-accounted for. Observers shall physically inspect dragheads and inflow and overflow screening/boxes for threatened and endangered species take.

(1). Monitoring Reports: The results of the monitoring shall be recorded on the appropriate observation sheets. There is a sheet for each load, a daily summary sheet, and a weekly summary sheet. In addition, there will be a post dredging summary sheet. Observations sheets will be completed regardless of whether any takes of whales, or sea turtles occur. In the event of any sea turtle or take by the dredge, appropriate incident reporting forms shall be completed. Additionally, all specimens shall be photographed with a digital camera. These photographs shall be attached to respective reports for documentation. Dredging of subsequent loads shall not commence until all appropriate reports are completed from the previous dredging load to ensure completeness and thoroughness of documentation associated with the incidental take Reports shall be submitted to the CO or COR within 24-hours of the take.

(2). Endangered Species Observer(s): A list of ESOs that have been NMFS-approved to monitor threatened/endangered species takes by hopper dredges can be obtained by contacting NOAA Fisheries' Northeast Region, Protected Resources Division. The main contact is Ms. Julie Crocker; she can be reached at julie.crocker@noaa.gov or 978-281-9300 ext.6530.

(3). Digital Photographs: The Contractor shall use a digital camera, with an image resolution capability of at least 300 dpi, in order to photographically report all incidental takes, without regard to species, during dredging operations. Immediately following the incidental take of any threatened or endangered species, images shall be provided, via email, CD, DVD, or USB (thumb/flash/jump drive) to the Contracting Officer's Representative in a .JPG or .TIF format and shall accompany incidental take forms. The nature of findings shall be fully described in the incidental take forms including references to photographs.

Manatee, Sea Turtle, Smalltooth sawfish and Whale Sighting Reports

Any take concerning a manatee, sea turtle, smalltooth sawfish or whale; or sighting of any injured or incapacitated manatees, sea turtles, smalltooth sawfish or whales shall be reported immediately to the CO or COR by notifying the personnel indicated in the table "Order of Contact of Corps Personnel" above.

A copy of the incidental take report shall be provided to the CO within 24 hours of the incident. The Contractor shall also immediately report any collision with and/or injury to a manatee to the Florida Fish and Wildlife Conservation Commission "Manatee Hotline" 1-888-404-FWCC (3922) as well as the U.S. Fish and Wildlife Service, Vero Beach Field Office 772-562-3909 for South Florida. If a sea turtle is taken by the dredge (live or dead) the contractor shall email a PDF version of the incidental take report to NOAA-Fisheries Southeast Region at the following email address within 24 hours of the take - takereport.nmfsser@noaa.gov also providing a cc copy to the CO.

Report Submission

The Contractor shall maintain a log detailing all incidents, including sightings, collisions with, injuries, or killing of manatees, smalltooth sawfish (STSF), sea turtles, dolphins or whales occurring during the contract period. The data shall be recorded on forms provided by the CO. All data in original form shall be forwarded directly to Chief, Environmental Branch, P. O. Box 4970, Jacksonville, Florida, 32232-0019, within 10 days of collection and copies of the data shall be supplied to the CO. Following project completion, a report summarizing the above incidents and sightings shall be submitted to the following:

Chief, Environmental Branch
U.S. Army Corps of Engineers (CESAJ-PD-E)
P.O. Box 4970
Jacksonville, Florida 32232-0019

Area Engineer
U.S Army Corps of Engineers (CESAJ-CD-W)
4400 PGA Boulevard, Suite 203
Palm Beach Gardens, Florida 33410

U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, Florida 32960-3559

National Marine Fisheries Service
Protected Resources Division
263 13th Avenue South
St. Petersburg, Florida 33701

Florida Fish and Wildlife Conservation Commission
Imperiled Species Management Section
620 South Meridian Street, Mail Stop 6A
Tallahassee, Florida 32399-1600

MONITORING ASSOCIATED WITH BLASTING OPERATIONS AND POTENTIAL IMPACTS

A formal coordination meeting shall be held at least two days prior to the first blast event. Attendants will include the observers in the watch program, construction contractors, demolition subcontractors, and other interested parties, such as the U.S. Coast Guard, FDOT, NMFS, FWC, FWS, and DEP. The construction contractors, demolition subcontractors and observers will present the protocol and logistics of the project.

If blasting is proposed during the period of 1 November through 31 March, significant operational delays should be expected due to the increased likelihood of manatees being present within the project area. If possible, avoid scheduling proposed blasting during the period from 1 November through 31 March. In the area where blasting could occur or any area where blasting is required to obtain channel design depth, the following marine mammal (manatees and dolphins) and reptile (sea turtles and crocodiles) protection measures shall be employed, before, during and after each blast:

1) The Contractor shall prepare a Blasting Plan and provide it to the CO at least 30 days before the first blast event is scheduled. The environmental monitoring requirements during blasting shall include, at a minimum, the following.

a. A list of the observers and their contact information, their qualifications, and positions for the watch, including a map depicting the proposed locations for boat or land-based observers. Qualified observers must have significant prior on the job experience observing for protected marine species (including manatees, marine turtles, dolphins, etc.) during previous in-water blasting events where the blasting activities were similar in nature to this project. Each observer's past experience must 1) be in the same observer position proposed for this project; 2) include experience working as part of an observation team during an in-water blasting project; and 3) have extensive manatee or marine turtle observation experience during previous dredging or blasting projects and/or during manatee or marine turtle research studies.

b. The amount of explosive charge proposed, the explosive charge's equivalency in TNT, how it will be executed (depth of drilling, stemming, in-water, etc.), a drawing depicting the placement of the charges, size of each of the 4 zones identified in b. below and how it will be marked (also depicted on a map), tide tables for the blasting event(s), and estimates of times and days for blasting events (with an understanding this is an estimate, and may change due to weather, equipment, etc).

c. For each explosive charge placed, four zones will be calculated, denoted on monitoring reports and provided to protected species observers before each blast for incorporation in the watch plan for each planned detonation. These zones are:

(1) Danger Zone (ft) = 260 [79.25 m] X the cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

(2) Exclusion Zone (ft) = Danger +500.

(3) The Safety zone (ft) = 520 [158.50 m] X cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

(4) The Watch Zone is three times the radius of the Danger Zone to ensure that animals entering to traveling close to the Exclusion Zone are spotted and appropriate actions can be implemented before or as they enter any impact areas (i.e., a delay in blasting activities).

Detonation will not occur if a marine mammal or reptile is known to be (or based on previous sightings, may be) in the Exclusion Zone. Vessel-based surveys will be conducted within the Safety and Watch Zones; while Aerial surveys will cover all zones.

d. The watch program shall begin at least one hour prior to the scheduled start of blasting to identify the possible presence of manatees, dolphins, marine turtles, crocodiles or whales (in the nearshore and offshore areas). The watch program shall continue until at least one half-hour after detonations are complete.

The watch program shall consist of a minimum of six Protected Species Observers. Each observer shall be equipped with a two-way radio that shall be dedicated exclusively to the watch. Extra radios should be available in case of failures. All of the observers shall be in close communication with the blasting subcontractor in order to halt the blast event if the need arises. If all observers do not have working radios and cannot contact the primary observer and the blasting subcontractor during the pre-blast watch, the blast shall be postponed until all observers are in radio contact. Observers will also be equipped with polarized sunglasses, binoculars, a red flag for backup visual communication, and a sighting log with a map to record sightings. All blasting events will be weather dependent. Climatic conditions must be suitable for optimal viewing conditions, as determined by the observers.

The watch program shall include a continuous aerial survey to be conducted by aircraft, as approved by the FAA. The event shall be halted if an animal(s) is spotted within the Exclusion Zone (Danger Zone + 500 feet). An "all-clear" signal must be obtained from the aerial observer before detonation can occur. The blasting event shall be halted immediately upon request of any of the observers. If animals are sighted, the blast event shall not take place until the animal(s) moves out of the area under its own volition. Animals shall not be herded away, lured or harassed into leaving. Specifically, the animals must not be intentionally approached by project watercraft. If the animal(s) is not sighted a second time, the event may resume 30 minutes after the last sighting.

e. The observers and contractors shall evaluate any problems encountered during blasting events and logistical solutions shall be presented to the CO. Corrections to the watch shall be made prior to the next blasting event. If any one of the aforementioned conditions is not met prior to or during the blasting, the watch observers shall have the authority to terminate the blasting event, until resolution can be reached with the CO. The CO/COR will contact FWC, USFWS and NMFS.

f. If an injured or dead marine mammal or marine reptile is sighted after the blast event, the watch observers shall contact the CO/COR and the CO/COR will contact the resource agencies at the following phone numbers:

(1) FWC through the Manatee Hotline: 1-888-404-FWCC and 850-922-4330 (manatees).

(2) USFWS Vero Beach: 772-572-3909 (manatee and crocodile).

(3) NMFS SERO-PRD: 772-570-5312 (sea turtles and sawfish).

(4) NMFS-SEFSC- Emergency Stranding Hotline - 1-877-433-8299.

The observers shall maintain contact with the injured or dead mammal or reptile until authorities arrive. Blasting shall be postponed until consultations are completed and determinations can be made of the cause of injury or mortality. If blasting injuries are documented, all demolition activities shall cease. The CO/COR will then submit a revised plan to FWC, NMFS and USFWS for review.

g. The Contractor shall record the noise associated with 30 blast events on a hydrophone system capable of recording in broad frequency range (75 Hz - 350 kHz). The Contractor shall also record associated work as separate recordings, including borehole drilling and fish repelling charges. Files shall be provided as .wav binary files. The hydrophone shall have the ability to record the blast event, as well as providing voice recording of each hydrophone record in a standard format acceptable to the government (e.g., .cda files). The Contractor shall provide hydrophone records for: the first 20 production blast shots, five (5) production blast shots in approximately the middle of the blasting program, and five (5) production blast shots nearing the end of the blasting program. The Contractor shall provide nearby hydrophone records of drilling operations of 30 minutes over three (3) early contract periods at least 18 hours apart. The Contractor shall provide hydrophone records within the contract area of three (3) 10-minute quiet periods (not necessarily 10 continuous minutes) over three (3) early contract periods at least 18 hours apart or prior to the contractor's full mobilization to the site, and 10 close-approaches of varied vessel sizes. The Contractor shall record as many as 10 periods (not to exceed 30 minutes each) with a hydrophone system within the contract area at the direction of the CO, when provided with a one-week advance notice.

Information to be provided as both an EXCEL file and voice recording for each hydrophone record (.wav file) shall include:

(1) GPS Location of the hydrophone aboard the vessel. The GPS position shall use the same coordinate system as the Blasting Contractor. The vessel shall be moored approximately bow toward the blast/drilling site. The hydrophone shall closer to the blast pattern than the vessel's bow at the waterline. The hydrophone position shall be located outside the range that would cause clipping (overloading of the hydrophone, causing the absolute peaks to be lost).

(2) Water depth of the hydrophone and the water depth to the sediment/rock bottom. The hydrophone shall be placed at the shallower of 3.0 meters (9.84 feet or 9 feet, 10 inches) depth or the mid-water column depth.

(3) Information provided by the Blasting Contractor regarding the blast pattern or drilling. The minimum data shall include, as appropriate for blast shots or drilling; the date, time, and blast number of the shot; the average water depth of the shot pattern or the average depth to sediment/rock at the nearest five (5) shot-holes closest to the hydrophone location; GPS Location of the closest shot-hole in the blast pattern to the hydrophone; minimum explosive depth below the top of rock for the closest shot-hole in the blast pattern to the hydrophone; the maximum charge weight per delay of the shot pattern in pounds of explosives; and, the largest charge weight per delay of the closest delay sequence to the hydrophone.

Reporting: The protected species observers shall prepare a daily report for each blasting event. Data reported shall include:

(1). Event date; observer names; observer locations; weather conditions (cloud cover, wind speed; wind direction; glare; water clarity; water color; beaufort sea state; visibility and tide stage); watch start time; watch end time; total watch time; all zone radii (ft); sunrise time; and sunset time.

(2). A daily summary of protected species observed during the blast event (including species; total number of each species; total number spotted outside exclusion zone; total number spotted inside the exclusion zone; animal behavior inside the exclusion zone; actions taken by observer; comments).

(3). A detailed sighting log for each animal/group of animals (if animals are traveling in a group) including: time; species; total number of animals; number of adults/juveniles; location of reporting observer; closest distance to blast array; bearing from blast array; direction of travel; time of relocation (for each time the animal is relocated); time last seen).

(4). A map shall be prepared for each blasting event illustrating the project area, all zone radii and each animal (or group of animals), the time each animal was first observed and the direction of travel of the animal (or group).

(5). The daily report should be signed by the primary protected species observer for that blast event. Within 15 days after completion of all blasting events, the primary protected species observer shall submit a report to the CO/COR, who will provide it to FWC, NMFS and USFWS providing a summary description of the blasting events, number and location of animals seen and what actions were taken when animals were seen for each blast. Any problems associated with the events and suggestions for improvements shall also be documented in the report.

Fish Mortality Monitoring:

1. After each detonation and the "all clear" signal is given, the contractor shall collect the floating carcasses of/ bodies of fish in the blast zone using a dip net.
2. The carcasses will be inventoried and the attached data sheet for each individual blast completed for all collected fishes.
3. Specific species of fish require additional data to be collected.
   a) Tarpon:
      i) Girth in mm;
      ii) Fork Length and Total Length in mm; and
      iii) A fin clip will be collected for DNA analysis.
         (1) For each sample, record the time, date, and location of capture/sample.
         (2) Provide name and contact information for data collector, when samples are submitted.
   b) Permit:
      i) Fork Length and Total Length in mm;
      ii) A fin clip will be collected for DNA analysis;
      iii) For each sample (fin clip, gonad, and whole fish), record the time, date, and location of capture/sample; and
      iv) Provide name and contact information for data collector, when samples are submitted.
   c) Taking fin clip samples from tarpon and permit:
      i) Cut a piece of tissue from the fin with a pair of scissors; and
      ii) Place the fin clip into a labeled vial of ethanol.
      iii) If vials of ethanol are not available, place each fin clip into a clean plastic zip lock bag and immediately place on ice.

iv) As soon as possible, place the bag(s) with the fin clip sample(s) in the freezer for storage until preserved.

d) Samples shall be mailed to: Dr. Kathy Guidon, FWC-FWRI, 100; 8th Ave SE, St. Petersburg, FL 33701.

4. All collected carcasses, not transferred to another entity, shall be disposed of in a manner that will not result in "recapture" of the carcass at a later blasting event - on shore, in a trash receptacle.

Fish Mortality Reporting: Raw data for each day will be compiled onto the Blast/Dredge fish species account dataform. The daily dataform shall be completed and submitted to the Environmental Manager for posting on the project secure FTP site within 24-hours of the blast. A summary report shall be prepared and will be submitted within 30 days after the completion of all blasting operations. All samples submitted to FWC-FWRI shall be summarizes on a spreadsheet and submitted to the CO/COR, weekly.

TRANSPLANTATION AND MONITORING OF TRANSPLANTED CORALS

Scleractinian Corals:

A. Acropora (Staghorn Coral) Survey and Relocation - ***This relocation effort will only be undertaken if Acropora sp. corals are located within 150-m of in the existing or proposed channel footprint. The requirements of this section are taken from the Acropora sp. relocation requirements found in the NMFS Biological Opinion issued for the Miami Harbor Project dated September 8, 2011.***

Fragment Collection

1) Prior to colony collection for relocation, each colony will be photographed, measured in situ and a visual health assessment will be conducted.

2) A 5-cm fragment, or the whole colony for any colonies 5-cm or smaller, is collected from each parent colony. The fragment must be collected from the axial tip of healthy branches using hand tools (e.g., clipper). Fragments must remain in seawater until transfer to the custody a permitted *A. cervicornis* coral nursery within Dade County, Broward County or the Florida Keys. The CO/COR will coordinate with the appropriate *Acropora* nursery prior to collecting these samples to ensure safe transfer. If a colony is less than or equal to 5-cm in length, the entire colony will be collected and treated as a fragment.

3) A second photograph of the colony is taken after the tip is collected, if the colony is greater than 5-cm in size.

Acropora Colony Relocation

1) Colonies will be collected carefully using a hammer and chisel. Upon collection, the colonies must be kept in bins and maintained in seawater at all times. The collected colonies must be kept at the original depth by caching them at the collection site until transplantation commences, and the colonies must be secured in a manner to prevent the container from overturning or the colonies from floating out of the container. A screen is recommended by NMFS to allow for sufficient water circulation while maintaining the colonies in the container. During transportation to the transplant site on board the transfer vessel, the corals must be covered. Transplantation will occur as soon as an operationally feasible and no more than 24-hours after the colony is removed from its original location. If the colonies cannot be transplanted within 24-hours due to weather, equipment failure, emergency or other operational limitation, the Contractor shall notify the CO/COR immediately, who will coordinate with NMFS regarding the delay.

2) All transplanted *Acropora cervicornis* colonies will be re-located to suitable habitat near their original location, between 550 feet - 2,500 feet from edge of the channel on either the north or south side of the channel based upon the original collection location within 24-hours of collection. Suitable habitat is considered: similar depth as origin (+/- 5 ft); consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover occurring in water depths from the mean high water (MHW) line to 30 meters (98 feet); appropriate water quality (based on water quality data and local knowledge), and minimal chances of

other disturbances (boat groundings, damage caused by curious divers/fisherman). All efforts should be made to transplant the fragment to the same depth from which it was removed (i.e., +/- 5 ft).

3) Colonies will be attached to suitable substrate with All Fill Epoxy. Before applying the epoxy to the substrate, the substrate will be cleaned of any sediment or algae. The epoxy should then be taken out of the dry lock bag and pressed against the clean substrate. The transplanted colonies will then be pressed gently into the epoxy with proper care. Transplanted colonies must be placed no closer than 0.75 meters from one another.

4) To assist in monitoring efforts, a plastic identification tag must be attached adjacent to each transplanted colony. Finally, the collected location, length, width, depth and orientation of each colony to be transplanted will be recorded. A photograph of the *Acropora cervicornis* colony will be taken at the transplanted location and depth of each colony, as well as the species and identification number will be recorded.

5) After transplantation is complete and is documented photographically, the Contractor shall also conduct a Health Assessment of the transplanted colony. The assessment will review and report the following conditions:
   a. Bleaching and/or paling of tissue or other discoloration.
   b. Recent mortality (denuded skeleton to development of fine "fuzz" on branches indicating mortality within a couple of weeks prior to observation).
   c. Bearded fireworm, *Hermodice carunculata* or the gastropod *Coralliophila abbreviata* in feeding positions (at tissue loss margin).
   d. Microbial mat (e.g., black band cyanobacteria and other organisms at tissue loss margin).
   e. Growth anomalies (altered morphology of tissue and skeleton).

B. Non-*Acropora* Hard Coral Species

Scleractinian corals >10 cm in maximum diameter or height shall be collected from direct impact areas in the Middle (2nd) and Outer (3rd) Reef expansion areas and transplanted to the mitigation reef. Colonies with signs of disease, boring sponge infestation, or colonies that are not expected to survive transplantation shall not be relocated.

Healthy scleractinian corals (without diseases and boring sponges absent) shall be carefully removed from the substrate using a chisel and hammer, and either cached for a short period of time (1-2 days, with no storm in the forecast) in a safe place on the collection site, or collected into baskets and lifted by a diver as the basket is filled or at the end of the collection dive, wrapped in bubble wrap, and then transferred into cooler containers filled with seawater, and transported to the designated transplant areas.

The attachment of corals to the substrate shall be conducted in such a manner that corals of the same species will form small groups of 10-20 colonies growing close to one another with an average density of about 1.4 colony per meter^2 for larger corals. Corals shall be transplanted preferably on micro-relief features (bumps, hills, etc, scale of 0.1-0.3 meters) on the tops of boulders in the artificial reefs; *Agaricia* spp., *Madracis* spp., and *Mycetophyllia* spp., can be transplanted on to vertical or subvertical parts of the mitigation reefs. If found, corals of the genera *Mycetophyllia, Scolymia, Colpophyllia, Dendrogyra, Mussa, Isophyllia, Isophyllastrea, Favia,* and *Acropora* shall be transplanted irrespective of size. The surface of the substrate in the recipient location shall be cleaned of algae, cyanobacteria, and sediments with a wire brush. Portland cement and/or underwater epoxy glue can be used for the attachment of scleractinian coral colonies.

The time in the cooler prior to transplantation shall be minimized as much as possible. Coolers shall be kept in the boat away from direct sunlight and external heating.

II. STRUCTURAL ARTIFICIAL REEF MONITORING

If corals are transplanted to an artificial reef constructed as mitigation for the deepening project, and providing that scleractinian corals >10 cm in maximum diameter are transplanted as specified above, artificial reef(s) of 5.0 acres shall be built in a location to be determined north of the channel in the sandy trough between the Outer (3rd)

and Inner (2nd) reefs, as mitigation for unavoidable impacts to coral reefs and hardbottom communities from the Project. The artificial reef(s) shall be built of limestone boulders such that the sand patches between the boulders do not exceed 10% of the total reef area. Comparable to the Middle (2nd) and Outer (3rd) reef impact sites, 31% of artificial reef with a low relief of three (3) feet or less and varying rugosity due to the placement of boulders will be constructed. 69% of the artificial reef shall contain higher relief of 10 feet or less and varying rugosity. The rugosity will be measured via side-scan and multibeam survey and reported as part of the as-built surveys.

Monitoring of the artificial reef shall require:

1. A pre-construction bathymetric survey will be conducted to establish baseline conditions. The survey will be used to compare to future post-construction surveys to evaluate any evidence of subsidence.

2. A post-construction bathymetric (multibeam) and side scan survey will be conducted after all reef mitigation material has been placed in its designated site. A comparison between the pre- and post-construction survey will evaluate if the proper amount of high relief high complexity (HRHC) and low relief low complexity (LRLC) was achieved. The survey information will be utilized to demonstrate the boundaries of the sites (including total acreages), relief of the sites (provided in a color coded map to distinguish areas of low and high relief, with total acreages of each relief type), rugosity, and interstitial area (percent sand cover versus percent boulder cover for each reef unit/pile). Calculations for high relief areas and low relief areas are to be conducted separately. Cross sections will be taken at 50 foot intervals to determine relief, rugosity, and interstitial area. The calculations would be run on each cross section, and an overall average. Towed or pole mounted video would be conducted at 100 foot intervals as verification of the survey information. Diver surveys (line-intercep measurements) would only be conducted if the bathymetric survey information is determined to be deficient for estimating the criteria cited above.

   Corrective measurements shall be undertaken if the results of the artificial reef surveys show that less than the required acres of artificial reef is constructed, or if one of components (low relief/high relief) of the artificial reef is incorrect.

Schedule. Within the first 45 days after construction, a bathymetric survey of the mitigation site(s) and mapping of the outline of the reef shall be conducted, and then all other parts of the as-built survey shall follow. If any settlement occurs to the level that the top elevation is not within design tolerances, additional material must be added to make it comply. One final survey will be conducted at 90 days post construction, to ensure physical compliance with the design, prior to biological monitoring and/or relocation of corals to mitigation site beginning.

Reports. The as-built survey report shall be submitted within 45 days of the completion of the survey. .

POST CONSTRUCTION MONITORING

Monitoring of Remaining Dredge induced stress

1. If hardbottom and reef habitats along either side of the channel are documented as exhibiting sediment-induced stress associated with dredging operations during the construction surveys performed by the USACE contractor, long term biological monitoring will occur for up to three years post construction to document effected organisms' recovery or loss.

   a. The biological monitoring effort will be coordinated with the agencies once the results of the construction monitoring program are evaluated and it has been determined that sediment stress occurred.
   b. The monitoring program is expected to duplicate the construction monitoring baseline and construction stations, with surveys twice a year for a period up to three years.
   c. An annual summary report will be submitted within 120 days upon completion of each annual monitoring event.

Monitoring of Transplanted Scleractinian Corals:
The size of all scleractinian corals shall be measured prior to the detachment (only the largest dimension), then, after the detachment, sorted and recorded by the species and size classes: I: 25-50 cm; II: >50 cm). After the transplantation of scleractinian corals, depending on their number, the monitoring mode will be selected. 15% of all the estimated 11,502 (1,725) relocated corals shall be tagged and monitored. All size classes of each species of corals represented during the collection of corals in the impact zone shall be represented in the monitoring surveys.

For each relocated species, an aggregate of 10 reference colonies of any size will be identified, unless the number of transplanted corals was less than 10, in which case the number of control colonies shall be the same as the number of transplanted corals. Corals represented by a single colony shall not be required to have controls for monitoring. All corals selected for tagging and monitoring, including each reference colony will be photographed with a ruler present for scale. At least one photograph should be above the colony from fixed distance to be able to estimate surface area of the colony. At least one photograph should contain the unique identifier label. The following information will be recorded for each coral selected for tagging and monitoring, including each reference colony:

1) Species (to the lowest taxonomic rank possible)
2) Colony size. Scleractinian corals, this will include length (longest axis), width (perpendicular to longest axis), and height (in direction of growth).
3) Depth of water where colony is located.
4) Colony orientation.
5) Overall health (i.e. presence of disease or bleaching, percent live tissue). Reference colonies will, to the greatest extent possible, be free of notable disease, bleaching or other indicators of stress. It is recognized, however, that this may not be possible when regional or broader scale stress inducing events occur.
6) Location of the colony, through either GPS coordinates of the colony or GPS coordinates for a reference location (or relocation) and distance and compass bearing from the reference location.

Monitoring for scleractinian corals relocated to the transplantation site(s) and at the control sites shall be conducted at the following stages: one month after the transplantation, 6 months after transplantation; 1 year after transplantation; and 2 years after transplantation. After the 2 years of monitoring the success of the transplants will be estimated.

Success of scleractinian coral transplantation shall be based on the following criteria: 85% for corals measuring >25cm; 75% for corals measuring 11 cm-24cm. All survival rates shall be compared to survival rates at the baseline control sites and tested for statistically significant differences to capture potential effects of region-wide impacts associated with events outside of the scope of the dredging project.

The initiation and completion of transplantation and the transplantation progress shall be reported to the FLDEP JCP Compliance Officer via e-mail weekly or the information will be made available by web site. Monitoring reports shall be submitted within 90 days upon completion of each survey. Initiation and completion of each survey shall be reported to the FLDEP JCP Compliance Officer.

Mitigation - Artificial Reef Biological Monitoring Protocol

1. ***Permanent Transect Establishment and Monitoring.*** In order to monitor benthic colonization and succession, four (4) 20-meter long permanent monitoring transects per acre of artificial reef shall be established with ten (10) 1-meter square quadrats per transect.
   a) Photographs of each quadrat shall be taken to supplement quadrat in situ data along each transect, or
   b) Video Documentation shall be collected along the 20-meter long transects to supplement the quadrat data and analyzed using standard PonitCount99, CPCe, or approved similar method.

2. ***Schedule.*** Within 30 days following construction of the artificial reef, the bathymetric survey of the outline of the reef shall be conducted, and then all other parts of the as-built survey shall follow. The artificial reef permanent monitoring transects shall be monitored annually (summer) for five years following placement of

the artificial reef. During the final (fifth) monitoring survey, the artificial reef shall be mapped once again (repeat as-built survey).

3. ***Success.*** Success will be achieved when the benthic community and colonization of the mitigation reef has been documented to be comparable to the benthic community and species composition documented in the impact area of the 2^{nd} and 3rd reef during the preconstruction survey (DCA, 2009). Successful mitigation shall be defined by the following criteria: 75% of species found in the impact site shall be present in the mitigation site by the time of the completion of the monitoring period; and percent cover by the major groups of organisms in the mitigation site shall be no less that it was in the impact site. Utilization of multi-variate analysis and computing Bray-Curtis similarities to compare reference and mitigation sites will be required.

4. ***Adaptive Management*** - If the artificial reef has either less acreage than was required in the permit by the time of final (5th) survey, or succession does not achieve the status of communities that existed at the impact site (criteria indicated above), then additional mitigation shall be required. Specific threshold triggers for adaptive management are listed in the table on pages 22-23 of this report. An alternative would be the transplantation of additional corals to the artificial reef site. These corals could come from the collection of "orphan corals" commonly found dislodged from the natural reef environments or from coral nurseries maintained by other entities (NGOs, academia, local governments).

5. ***Reports.*** The as-built survey report shall be submitted within 30 days of the completion of the survey. The annual mitigative artificial reef monitoring reports shall be submitted within 90 days of the completion of each annual monitoring event, but no later than 1st of December of each year. Monitoring progress shall be reported weekly until the completion of each survey, at which point the JCP Compliance Officer shall be notified that the survey is complete. Each annual report shall document the colonization of the artificial reef and compare the species composition on this reef to that documented in the impact area during the preconstruction survey. Annual monitoring reports shall include:

- A map of the artificial reef with the associated monitoring transects plotted on it;
- An analysis of the quantitative quadrat data on the benthic biological components of the artificial reef monitoring transects (*e.g.*, percent cover by corals, octocorals, sponges, algae, etc.);
- A comparative analyses of the mitigative artificial reef and natural hardbottom resources to determine mitigation success;
- An analysis of succession based on the comparison of benthic communities found on the artificial reef and natural communities (impact site) by comparison of such parameters as densities, size class distribution, etc.;
- Current acreage, relief, and rugosity of artificial reef (for final report only);
- Copies of all transect video submitted on electronic media (external hard drives); and,
- All raw data in the format that was used for the analysis.

Mitigation – Nursery Propagated Corals (Performance Measures for Nursery Operations)
(Prepared by NMFS-HCD/NMFS-Restoration)

Performance Measures for Nursery Operations

Continuous (project duration)	Trigger for adaptive management	Adaptive management action
Coral fragments and reef organisms are attached to nursery platforms	Unattached coral fragments or reef organisms observed	Re-attach loose coral fragments and reef organisms
Algae is not negatively impacting growth or health of coral fragments or reef organisms	Algae observed contacting with live tissue of coral fragments or reef organisms	Remove algae
Sedimentation is not negatively impacting growth or health of coral fragments or reef organisms	Coral fragments or reef organisms fully or partly buried or tissue abrasion observed	Remove sediment or re-evaluate suitability of the site
Disease is managed	Disease observed on more than 15% of coral fragment or reef organisms	Isolate or prune diseased coral fragments and reef organisms
Disease transmission vectors (e.g., fish, snails, worms) are managed	Fish, snails, and worms that are known to transmit disease and disease are observed	Remove suspected disease transmission vectors
Predation on coral fragments and reef organisms is managed	Predators or signs of predation observed in the nursery	Remove predators manually or by traps
Damage from storms is repaired	Nursery checked immediately after storms and damage is observed	Repair damage
Nursery materials (e.g., growout trees and lines) are in good working order	Degraded or broken materials observed	Repair damage
Water quality in land-based nursery maintained for health and growth of coral and reef organisms	Low growth or poor health of coral fragments or reef organisms observed	Adjust light, temperature, pH, salinity, alkalinity, calcium, nitrates, and phosphates as needed
Short-term (1 to 6 months)	**Trigger for adaptive management**	**Adaptive management action**
Medium-term (6 to 12 months)	**Trigger for adaptive management**	**Adaptive management action**
On target for to meet year 1 coral outplant target*.	Less than 90% of target	Increase the capacity for more corals through increasing the number of PVC trees, platforms, lines, or other nursery materials
Annual	**Trigger for adaptive management**	**Adaptive management action**
On target for to meet annual coral outplant target* for area of reef to be restored that year.	Less than 90% of target	Increase the capacity for more corals through increasing the number of PVC trees, platforms, lines, or other nursery materials

*Annual targets may change depending on the methodology/time period the contractor proposes but should be established before the project begins as part of the contract milestones.

<u>Mitigation - Outplanted Propagated Corals (Performance Measures for Each Reef Enhancement Location)</u>
(Prepared by NMFS-HCD/NMFS-Restoration)

The Corps coral propagation contractor shall be required to monitor the outplanted propagated corals for a 3-year period for each outplanting area. After 3-years of monitoring of each outplanting area, the final determination of success for that outplanting area will be made and that area will no longer be monitored.

Outplanted nursery corals shall be monitored for survival and Adaptive Measurement Measures shall be taken to ensure survival remains above 80% based on the Monitoring and Adaptive Management plan found in Appendix E-5 of this plan. Survival shall be compared to control sites with similar species composition as the outplant sites to detect any region-wide changes or stochastic events like disease or a hurricane. The project shall reflect similar coral survival as the control sites for the outplanted species. Control sites shall be selected by the contractor, reviewed by the Corps and the Adaptive Management Committee and approved by the Contracting Officer.

3	Year 1	Start up nursery					
4	Year 2	Outplant area 1					
5	Year 3	Monitor area 1	Outplant area 2				
6	Year 4	Monitor area 1	Monitor area 2	Outplant area 3			
7	Year 5	Monitor area 1	Monitor area 2	Monitor area 3	Outplant area 4		
8	Year 6		Monitor area 2	Monitor area 3	Monitor area 4	Outplant area 5	
9	Year 7			Monitor area 3	Monitor area 4	Monitor area 5	Outplant area 6
10	Year 8				Monitor area 4	Monitor area 5	Monitor area 6
11	Year 9					Monitor area 5	Monitor area 6
12	Year 10						Monitor area 6

Tier 1 Monitoring
General site assessment including overall measurement; estimates of expansion, breakage, bleaching, & disease; and establishment/reoccupation of permanent oblique photo stations. Estimated to require 1 dive utilizing 3 divers.

Tier 2 Monitoring
Collecting of underwater Photo Mosaic* or appropriate number of random photo transects; establishment/reoccupation of permanent belt-transects and quads(to field measure size/species distribution and recruitment); General site assessment including overall measurement; estimates of expansion, breakage, bleaching, & disease; and establishment/reoccupation of permanent oblique photo stations. Post-field analysis of photo mosaic includes mapping of coral/sponge occupied areas, sitewide coral cover (CPCe on mosaic), site expansion mapping. (Note: Photo mosaics).

**Tier 2 Monitoring is anticipated to utilize underwater georeferenced photo-mosaics (essentially underwater aerial photography collected by a diver on a single dive) to increase mapping precision and decrease the amount of field time required for monitoring. This newly available coral monitoring resource that can significantly reduce field monitoring time and as a result monitoring costs, while at the same time establishing a permanent record of site conditions that can be evaluated by decision makers and the mitigation committee (see example at http://web2.physics.miami.edu/~agleason/mosaic_results/puerto_rico_acropora/margara_2013_aug.html)*

Adaptive Management Committee
A committee consisting of USACE, NMFS, the implementing partner and other applicable resource agencies and will meet on a regular schedule, unless the committee determines only an as needed basis is warranted. The

implementing partner will have the authority to make minor corrective actions under the contract. However, corrective actions that require major adaptive management action (e.g., site abandonment) will be reviewed by the committee and the committee will make a recommendation to USACE. USACE has the sole authority to require the implementing partner to undertake changes under the contract.

Minor and Major Adaptive Management Actions
The committee will define what constitutes a minor versus a major corrective action and determine if the monitoring duration should be extended. For example, minor adaptive management actions may reset clock by 6 months and major adaptive management actions reset clock by 18 months.

Performance Measures for Each Reef Enhancement Location

Monitoring Events	Core Monitoring Sites *(25% of Sites)*	Non-Core Sites
Pre-Enhancement	Tier 2	Not Required
Post-Enhancement	Tier 2	Not Required
6 Months	Tier 1 + Outplant Count	Tier 1
12 Months	Tier 1	Not Required
18 Months	Tier 2	Tier 1
24 Months	Tier 1	Not Required
36 Months	Tier 2	Not Required
Post-Major Storm	Tier 1	Tier 1
Post-Minor Corrective Action	Tier 1	Not Required
Post-Major Corrective Action	Tier 2	Tier 1
Performance Measures		
6 Months	**Trigger for adaptive management**	**Adaptive management action**
Site maintains a minimum of 1.4 outplants p/sq. meter sitewide @ 6 months (contractor perf requirement)	<1.4 outplants p/ sq. meter site wide	Re-assess site for suitability. If site not suitable identify and outplant new site as a contractor responsible corrective action; if suitable outplant additional organisms as a contractor responsible corrective action. Restart monitoring and reassess 6 months post corrective action.
All corrective actions between time zero and 6 months are the responsibility of the contractor.		
18 Months	**Trigger for adaptive management**	**Adaptive management action**
Area of site mapped/measured as enhancement (growth of outplants + new recruits) has increased by a range of 6 to 10% above the time zero	If after 18 months cover has not increased from previous event.	

measurement once adjusted for any coral area decreases relative to any decreases in reference sites.**		
36 Months	**Trigger for adaptive management**	**Adaptive management action**
Area of site mapped/measured as enhancement (growth of outplants + new recruits) has increased by a range (14 to 18%) above the time zero measurement once adjusted for any coral area decreases relative to any decreases in reference sites.**	If after 36 months, cover has not increased from previous event.	
Dislodgement of fragments less than reference sites.		
All Monitoring Events		
Disease, Breakage, Bleaching, and Predation that could result in a failure to achieve the 18 or 36 month performance measures.	>20% above reference	

** If at Time Zero a Tier 2 Monitoring site is measured (via mosaic mapping) to have 20% of its area as enhanced *(need to tighten up the definition of this and mapping methodology in the monitoring plan)* and we expect an annual increase in area of 8.25% at 18 months and 16.5% at 36 months if the site is trending along the recovery curves in the HEA.

EIS
SUB-APPENDIX F

ENDANGERED SPECIES ACT (ESA) CONSULTATION

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

Section 7 Consultation Package –

National Marine Fisheries Service

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

F/SER31: KL
SER-2012-03723

MAR 07 2014

Mr. Eric Summa
Jacksonville District Corps of Engineers
Department of the Army
P.O. Box 4970
Jacksonville, Florida 32232

Mr. Chris McArthur
United States Environmental Protection Agency
Region 4
Atlanta Federal Center
61 Forsyth Street
Atlanta, Georgia 30303

Re: Port Everglades Expansion Project, Broward County, Florida

Dear Mr. Summa and Mr. McArthur:

The enclosed document constitutes the National Marine Fisheries Service's (NMFS) Biological Opinion based on our review of the U.S. Army Corps of Engineers' (USACE) planned dredging activities for the expansion of Port Everglades, and the Environmental Protection Agency's (EPA) expansion of the Offshore Dredged Material Disposal Site as an interrelated and interdependent activity. This Opinion is based on project-specific information provided in the consultation packages in addition to NMFS's review of published literature. This Opinion analyzes the project effects on whales, Johnson's seagrass, sea turtles, smalltooth sawfish, staghorn coral and six corals proposed for listing, as well as designated critical habitat for elkhorn and staghorn coral and proposed critical habitat for the NWA DPS of loggerhead sea turtles. We believe that the proposed project is likely to adversely affect, but is not likely to jeopardize, the continued existence of sea turtles, Johnson's seagrass, staghorn coral and proposed corals, and is not likely to destroy or adversely modify designated critical habitat for elkhorn and staghorn corals.

This Opinion includes a conference opinion on 6 species of proposed corals, and the proposed reclassification of staghorn coral from threatened to endangered. As such, if the proposed listings and reclassification are finalized in June 2014, the USACE will need to contact NMFS to determine the mechanism for authorizing the take of corals necessary to implement this action as proposed. Since the USACE has requested conference consultation on the proposed species, at the proper time they must also request that this Conference Opinion be confirmed as NMFS's Biological Opinion.

We look forward to further cooperation with you on other USACE and EPA projects to ensure the conservation and recovery of our threatened and endangered marine species. If you have any questions regarding this consultation, please contact Kelly Logan by phone at 727-460-9258 or by email at Kel.Logan@noaa.gov.

Sincerely,

Miles M. Croom

for Roy E. Crabtree, Ph.D.
Regional Administrator

Enclosure
File: 1514-22.F.4

Endangered Species Act - Section 7 Consultation
Biological Opinion

Agency: United States Army Corps of Engineers (USACE) and United States Environmental Protection Agency (EPA)

Applicant: USACE Planning and Civil Works Division

Activity: Dredging and Expansion of Port Everglades, Broward County, Florida

Consulting Agency: National Marine Fisheries Service (NMFS)
Southeast Regional Office
Protected Resources Division

NMFS Consultation No. SER-2012-03723

Date Issued: MAR 07 2014

Approved By: Miles M. Croom
for Roy E. Crabtree, Ph.D.
Regional Administrator

Glossary of Commonly Used Acronyms

CCA	Crustose Coralline Algae
DPS	Distinct Population Segment
DWH	Deepwater Horizon
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973
HCD	Habitat Conservation Division
ITS	Incidental Take Statement
MMPA	Marine Mammal Protection Act of 1972
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
ODMDS	Ocean Dredged Material Disposal Site
RBO	Regional Biological Opinion
RPMs	Reasonable and Prudent Measures
SARBO	South Atlantic Regional Biological Opinion
SEFSC	Southeast Fisheries Science Center
SERO	Southeast Regional Office
STSSN	Sea Turtle Stranding and Salvage Network
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

Background

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §1531 et seq.), requires that each federal agency ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of those species. When the action of a federal agency may affect a protected species or its critical habitat, that agency is required to consult with either National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the protected species that may be affected.

Consultations on most listed marine species and their designated critical habitat are conducted between the action agency and NMFS. Consultations are concluded after NMFS determines the action is not likely to adversely affect listed species or critical habitat or issues a biological opinion ("opinion") that determines whether a proposed action is likely to jeopardize the continued existence of a federally-listed species, or destroy or adversely modify federally-designated critical habitat. The opinion also states the amount or extent of listed species incidental take that may occur and develops nondiscretionary measures that the action agency must take to reduce the effects of said anticipated/authorized take. The opinion may also recommend discretionary conservation measures. No incidental destruction or adverse modification of critical habitat may be authorized. The issuance of an opinion detailing NMFS's findings concludes ESA Section 7 consultation.

This document represents NMFS's Biological Opinion ("Opinion") based on our review of impacts associated with the USACE's proposed dredging and expansion of Port Everglades ("Port Everglades Expansion project"), and the U.S. Environmental Protection Agency's (EPA) proposed expansion of the Ocean Dredged Material Disposal Site (ODMDS). This Opinion analyzes project effects on Johnson's seagrass, sea turtles, whales, smalltooth sawfish, staghorn coral, and designated critical habitat for elkhorn and staghorn corals in accordance with Section 7 of the ESA. NMFS based this Opinion on project information provided by the USACE as well as published literature and the best available scientific and commercial information. It is NMFS's Biological Opinion that the action, as proposed, is not likely to jeopardize the continued existence of Johnson's seagrass, sea turtles or staghorn coral, and is not likely to destroy or adversely modify the designated critical habitat for elkhorn and staghorn corals.

NMFS has also proposed to list 6 additional coral species, which may be found within the action area. The 6 species are: *Orbicella annularis, Orbicella faveolata, Orbicella franksi, Mycetophyllia ferox, Dichocoenia stokesii,* and *Agaricia lamarcki.* In addition, NMFS has proposed to reclassify *Acropora cervicornis* and *Acropora palmata* from threatened to endangered (77 FR 73220, December 7, 2012). The USACE has requested a formal Conference Opinion for these proposed corals. A conference consultation on the potential effects of the action on proposed critical habitat for the Northwest Atlantic DPS of loggerhead sea turtles is also included. Conference is a process of early interagency cooperation involving informal or formal discussions between the action agency and NMFS pursuant to Section 7(a)(4) of the ESA regarding the likely impact of an action on proposed species or proposed critical habitat. Conferences are: (1) required for proposed federal actions likely to jeopardize proposed species, or destroy or adversely modify proposed critical habitat; (2) designed to help federal agencies identify and resolve potential conflicts between an action and species conservation early in a project's planning; and (3) designed to develop recommendations to minimize or avoid adverse effects to proposed species or proposed critical habitat. [50 CFR §402.02, 50CFR §402.10]. This document will incorporate NMFS's Conference Opinion for the 6 proposed coral species and proposed loggerhead critical habitat based on our review of impacts associated with the Port Everglades Expansion project and expansion of the ODMDS. It is NMFS's Opinion that the proposed action will not jeopardize the continued existence of any of these proposed species or destroy or adversely modify the proposed critical habitat for the loggerhead Northwest Atlantic DPS.

BIOLOGICAL OPINION
1 Consultation History

On March 25, 2002, the USACE submitted a biological assessment for the Port Everglades Expansion project. Due to changes in the project design, listing of new species and designation of new critical habitat, ongoing information requests, and workload, consultation could only be completed recently. The following is a list of important consultation dates and activities:

- 2003 – Changes in ship simulations resulted in potential changes to project impacts; the USACE requested the consultation be suspended.
- September 17, 2004 – USACE submitted a revised biological assessment.
- May 9, 2005 – NMFS proposed to list elkhorn and staghorn corals.
- Late May 2005 – NMFS and USACE discussed the survey information previously provided to NMFS and determined that no additional surveys would be completed at that time.
- June 23, 2005 – USACE determined that the Port Everglades Expansion project may affect, but is not likely to adversely affect, elkhorn and staghorn coral.
- March 29, 2006 – USACE provided additional details and graphics regarding the disposal areas.
- May 9, 2006 – NMFS listed elkhorn and staghorn corals as threatened under the ESA.
- May 2006 – USACE conducted a reef survey to provide additional details on species composition at the end of the entrance channel.
- June 21, 2006 – USACE and NMFS biologists met to discuss project status and transfer information.
- June 23, 2006 – USACE sent draft of Port Everglades Reef Report.
- July 25, 2006 – USACE and NMFS met to discuss results of Port Everglades Reef Report.
- August 11, 2006 – NMFS provided comments on Reef Report to USACE. NMFS recommended that USACE complete a survey designed specifically to identify the presence and abundance of elkhorn and staghorn corals.
- August 18, 2006 – NMFS sent letter to USACE stating our belief that the coral reef survey study design was flawed.
- August-September, 2006 – USACE and NMFS coordinated by emails and agreed to a revised project area and updated seagrass reports.
- October 18, 2006 – USACE provided a letter responding to NMFS's determination that the original coral resource survey design was flawed.
- March 26, 2008 – NMFS sent a letter to USACE stating our concern that *Acropora cervicornis* may occur closer than the stated 3,500 feet (ft) from the entrance channel.
- April 28, 2008 – USACE and NMFS met to discuss project timeline and coral survey methodology. NMFS and USACE agreed to develop alternative survey methods for navigational channels in order to provide for human safety.
- December 2009 – Dial Cordy, Inc. finalized the Benthic and Fish Community Assessment Report.
- Summer 2010 – USACE conducted a new *Acropora* survey using the new alternative methods.

- October 2010 – USACE submitted the *Acropora* Survey Final Report to NMFS.
- October 12, 2010 – NMFS and USACE reviewed video and results of *Acropora* survey.
- August 2, 2011 – NMFS received information on a new *Acropora* survey conducted by the U.S. Navy. The survey found colonies of *Acropora* on the outer reef near the Port Everglades entrance channel. NMFS requested a hold on consultation until completion of the Navy report.
- December 2011 – NMFS received a copy of the final report from the Navy.
- February 13, 2012 – NMFS provided a copy of the final report from the Navy to the USACE.
- May 1, 2012 – NMFS and USACE met to discuss ongoing projects and timelines. During the meeting, NMFS requested that the USACE submit a complete consultation package for the Port Everglades Expansion project.
- September 5, 2012 – USACE submitted the final consultation package to NMFS.
- September 27, 2012 – USACE and NMFS met in St. Petersburg to discuss project status, possible alternatives, and ongoing NMFS concerns.
- October 16, 2012 – NMFS and USACE met in West Palm Beach with Dial Cordy, Inc. to discuss the towed video *Acropora* survey footage.
- December 7, 2012 – NMFS proposed to list 7 additional corals in the greater Caribbean region, 6 of which are documented in the project area.
- January 2, 2013 – USACE requested initiation of a formal conference opinion on the 6 proposed corals within the project area.
- January-May 2013 – NMFS worked on development of alternative coral reef mitigation options.
- May-October 2013 – NMFS and USACE developed "blended mitigation alternatives" to address impacts to coral reef resources.
- November 19-20, 2013 – NMFS and USACE met to resolve differences and composed a framework for a blended mitigation approach.

During the meeting held in St. Petersburg, Florida on November 19 and 20, 2013, NMFS and USACE resolved many of the remaining differences and completed the framework for a blended mitigation plan. USACE provided NMFS with a revised project description via email dated November 22, 2013 and we initiated formal consultation on that date.

2 Description of the Proposed Action

This consultation addresses the expansion of Port Everglades located within Hollywood, Broward County, Florida (see Figure 1). The total time frame for dredging is approximately 5 years. The propagation and outplanting of corals, a mitigation component of the proposed action, is expected to take 7 years with monitoring continued for an additional 3 years. The proposed project components are as follows (see Figure 2):

1. Deepen, widen, and extend the Outer Entrance Channel from an existing 45-ft project depth over a 500-ft channel width to 57 ft deep by 800 ft wide and extend it 2,200 ft seaward

2. Deepen the Inner Entrance Channel from 42 ft to 50 ft
3. Deepen the Main Turning Basin from 42 ft to 50 ft
4. Widen the rectangular shoal region to the southeast of the Main Turning Basin (Widener) by approximately 300 ft and deepen to 50 ft
5. Widen the Southport Access Channel in the proximity of Berths 23-26, referred to as "The Knuckle," by about 250 ft and relocate the U.S. Coast Guard (USCG) facility farther east on USCG property
6. Shift the existing 400-foot-wide Southport Access Channel about 65 ft to the east from approximately Berth 26 to the south end of Berth 29 to provide a transition back to the existing federal channel limits
7. Deepen the Southport Access Channel from about Berth 23 to the south end of Berth 32 from 42 ft to 50 ft
8. Deepen the Turning Notch, including the expanded portion, from 42 ft to 50 ft with an additional 100-foot north-south widening parallel to the Southport Access Channel on the eastern edge over a length of about 1,845 ft, and widen the western edge of the channel approximately 130 ft to provide access to the Turning Notch from the existing federal channel
9. Pre-treat rock substrates as necessary, including blasting
10. Dispose of dredged material not used for mitigation construction at the ODMDS, located east of the Port
11. Create approximately 5 acres of boulder reef
12. Relocate approximately 11,500 corals from within the impact area to the artificial boulder reef
13. Propagate and outplant corals, including between 35,000 and 50,000 *Acropora cervicornis* colonies
14. Temporarily relocate existing Aids to Navigation (ATONs) adjacent to the channel

All dredge depths may include up to 2 ft overdredge, meaning that the contractor(s) will be able to dredge to 2 ft below all depths identified above. Exact dredging methods will be determined later and will be dependent upon to whom the USACE awards the contract. Hopper dredges may be used prior to beginning the expansion to remove accumulated shoal material from the existing channel. Sand, silt, clay, soft rock, rock fragments, and loose rock will be removed via clamshell or suction dredge. Where contractors encounter hard rock, the USACE anticipates that explosives, and/or large cutterhead equipment will be used to remove the rock. Approximately 5.47 million cubic yards of material will be removed from all dredging activities to complete the expansion.

The use of explosives will be limited to areas inshore of the outer reef. The USACE estimates that up to 50% of the area to be dredged may require pre-treatment of hard substrate, and that there may be up to 900 days on which blasting takes place over the course of the 5-year construction period. The USACE will require the contractor(s) to use the following conservation measures to protect marine mammals and sea turtles:

1. A danger zone will be determined based on the explosive weight used and its effects during an open water detonation. This will give a conservative danger zone because the USACE will only use confined blasting techniques.

2. A combination of aerial observers, on water observers, and observers on the drill vessel will monitor the danger zone.

3. Any marine mammal or sea turtle within the danger zone shall not be forced to move out of these zones. Detonation shall not occur until the animal has moved out of the danger zone of its own volition.

4. In the event a protected species is injured or killed during the use of explosives, the USACE will immediately notify NMFS and engage in additional consultation prior to further use of explosives.

5. If explosives are used, the USACE will place the explosives in strategically oriented pre-drilled holes. These holes will be stemmed with angled gravel to direct the explosive energy into the rock.

6. The weight of explosives to be used in each blast will be limited to the lowest poundage of explosives that can adequately break the rock.

7. Drill patterns are restricted to a minimum of 8-foot separation from a loaded hole.

8. Hours of blasting are restricted from 2 hours after sunrise to 1 hour before sunset to allow for adequate observation of the project area for protected species.

9. Selection of explosive products and their practical application method must address vibration and air blast (overpressure) control for protection of existing structures and marine wildlife.

10. Loaded blast holes will be individually delayed to reduce the maximum pounds per delay at point detonation, which in turn will reduce the mortality radius.

11. The blast design will match the energy in the "work effort" of the borehole to the rock mass or target for minimizing excess energy vented into the water column or hydraulic shock.

12. Delay timing adjustments to a minimum of 8 milliseconds (ms) between delay detonations to stagger the blast pressures and prevent cumulative addition of pressures in the water.

13. Due to the likelihood of a large number of manatees in the area during the winter months, USACE has agreed as part of the ESA consultation with USFWS not to blast between November 15 and March 15. This will also help protect whales which migrate through this area in the early spring and late fall.

14. Test blasts will be performed prior to the actual project blasting. Observers will also be stationed to observe for endangered species prior to test and project blasts.

Safety radii are as follows:

1. The Danger Zone (NMFS refers to this as the Caution Zone): The radius in feet from the detonation beyond which no expected mortality or injury from an open water explosion is likely to occur (NMFS 2005c). The danger zone (ft) = 260 [79.25 m] X the cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

2. The Safety Zone is the approximate distance in feet beyond which injury (Level A harassment as defined in the MMPA) is unlikely to occur from an open water explosion (NMFS 2005c). The safety zone (ft) = 520 [158.50 m] X cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

3. The Watch Zone is 3 times the radius of the Danger Zone to ensure that animals entering or near the Exclusion Zone are spotted and appropriate actions can be implemented before or as they enter any impact areas (i.e., a delay in blasting activities).

4. The Exclusion Zone extends to 500 ft outside the Danger Zone radius. Detonation will not occur if a marine mammal or sea turtle may be within that zone (based on observational data).

Monitoring/watch plan. A watch plan will be formulated based on the required monitoring radii and optimal observation locations. The watch plan will be consistent with the program that was utilized successfully at Miami Harbor in 2005 and will consist of at least 5 observers including at least 1 aerial observer, 2 boat-based observers, and 2 observers stationed on the drill barge. A 6th observer will be placed in the most optimal observation location (boat, barge, fixed structure, shore, or aircraft) on a day-by-day basis depending on the location of the blast and the placement of dredging equipment, as determined by the blaster in charge and the chief protected species observer. This process will ensure complete coverage of the 3 zones as well as any critical areas. The watch will begin at least 1 hour prior to each blast and continue for one-half hour after each blast (Jordan et al. 2007).

Studies have shown that stemmed blasts have up to a 60% to 90% decrease in the strength of the pressure wave released, compared to open-water blasts of the same charge weight (Hempen et al. 2007; Hempen et al. 2005; Nedwell and Thandavamoorthy 1992). However, unlike open-water blasts, very little documentation exists on the effects that confined blasting can have on marine animals near the blast (Keevin et al. 1999). The blast mitigation procedures detailed above, in particular the rigorous observer program, have been successfully used in several USACE projects (i.e., San Juan Harbor, Puerto Rico, in 1994; Miami Harbor in 2005; and Wilmington Harbor in 2012).

The USACE will require the contractor(s) to follow the Terms and Conditions in NMFS's 1997 Regional Biological Opinion (RBO) on Hopper Dredging along the South Atlantic Coast. The

1997 RBO incorporates (by reference) NMFS's 1995 Biological Opinion on hopper dredging of channels and beach nourishment activities in the southeastern United States from North Carolina through Florida East Coast. The contractor(s) will be required to follow the Terms and Conditions in the 1997 and 1995 Biological Opinions mentioned above, with the exception of the conditions related to the southeast United States' North Atlantic Right Whale calving area, because the proposed project is not located in or near the calving area. The USACE will also require the contractor(s) to follow the enclosed NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*, dated March 23, 2006 (Appendix B).

Based on info from the DEIS (USACE 2013), current impact estimates show expanding the Port's Outer Entrance Channel will directly affect (via dredging) less than 8 acres of seagrasses, including 4.67 acres of Johnson's seagrass, 1.2 acres of mangroves, and 21.66 acres of coral reef habitat. The USACE will use mitigation credits at Westlake Park for losses of seagrass and mangroves. Further, approximately 98 to 118 acres of coral reef habitat may be impacted by sedimentation and anchoring of dredging vessels, depending on the methods ultimately used. The USACE anticipates that the methods used will likely result in the lower end of these effects; thus, the Port Everglades Expansion project includes mitigation actions to compensate for impacts to approximately 120 acres containing corals and coral reef. NMFS and the USACE worked together to create a "blended" mititgation plan, consisting of artificial reef creation and enhancement, and propogation and transplantion of sponges and corals, including listed staghorn corals, to natural reefs. The draft Habitat Equivalency Analysis, draft mitigation plan, and final meeting notes from collaborative meetings held in November 2013 (all of which can be found within the consultation documents for this project) were used to develop the following agreed-upon elements of mitigation:

1. *Creation of approximately 5 acres of artificial boulder reefs.*
   USACE proposes to deploy piles of limestone that have either been quarried and transported to the mitigation area, or dredged from the channel construction areas. The exact layout and artificial reef sites will be determined as part of the final mitigation plan.

2. *Relocation of approximately 11,500 corals from the impact area to artificial boulder reefs.*
   Approximatley 11,500 corals are proposed to be relocated from the impact area to the created artificial boulder reefs. Corals are removed from their natural substrate using hand tools, such as chisels and hammers. Depending on the distance to the outplanting site, the dislocated corals are transported either underwater by the diver or in seawater-filled containers at the surface. The corals are then attached to the artificial boulder reef using technologically proven standards. The density of the outplants will approximate the density in which they occurred in their natural state.

3. *Propagation and outplantation of corals and sponges, including between 35,000 and 50,000 staghorn coral colonies*
   The USACE proposes to enhance partially degraded reef sites near to, but not directly in or adjacent to, the area impacted by the Port Everglades Expansion project. This proposed reef mitigation project would enhance degraded reefs through the placement (outplanting) of regionally appropriate corals and sponges at appropriate density and

numbers as determined by NMFS. The organisms for outplanting would be sourced from corals and sponges of opportunity or propagated within in situ or ex situ coral nurseries. The exact numbers and proportions of the various coral species outplanted will be determined as part of the final mitigation plan. The USACE anticipates that between 35,000 and 50,000 colonies of staghorn coral will be part of the suite of outplanted organisms. The USACE anticipates that this portion of the mitigation (setting up or augmenting nurseries, growing corals and outplanting enough to meet the mitigation goals) will take up to 7 years to meet their mitigation requirements,with monitoring continuing for up to an additional 3 years.

Coral nurseries currently exist within Broward County and could be the source of the outplanted corals. However, it is possible that the volume of corals needed for the Port Everglades mitigation actions will exceed the capacity of existing nurseries; thus, new nurseries may be established. Scientifically vetted best practices for nursery propagation, outplanting, and monitoring have been developed and used by nursery managers in the Florida Keys, Broward County, Puerto Rico, U.S. Virgin Islands, and other Caribbean islands to reproduce *Acropora* spp. asexually (e.g., Johnson et al. 2011). Typical coral nursery establishment includes collection of small fragments less than 5 centimeters in diameter from the reef and holding the fragments in an underwater or tank-based nursery environment through their juvenile life stage. Corals of opportunity (i.e., fragments or colonies found already broken or dislodged from reef substrates) are the preferred source of fragment stock for the nursery; however, sometimes wild colonies must be sampled to obtain nursery stock. Small branch clippings from wild donor colonies can be collected using a variety of cutting tools, including stainless steel surgical bonecutters, diagonal electrical wire cutters, needle-nose pliers, etc. For colonies with thicker branches, PVC cutters have also proven effective. Branches are cut cleanly and evenly to ensure optimal survival of the fragment as well as rapid healing and recovery of the donor colony (Johnson et al. 2011). Offshore nurseries are sited to balance a number of factors including, among others, appropriate habitat and water quality conditions, potential for future impacts, and permitting. The physical and genetic origin of each coral is tracked from fragment collection to ensure that both nursery and outplanting operations are done in a scientifically responsible way. Regular maintenance is performed on nursery structures and the corals themselves to ensure all are free of coral competitors and predators. Once coral fragments have grown to a size where the probability of survival on natural reefs has increased to an acceptable level (this usually requires 12 to 18 months), the corals are outplanted to the natural reef.

Similar to nursery siting, outplanting sites are selected balancing several factors to maximize success. During outplanting, care is taken to ensure external stresses are minimized and that a population with an acceptable level of genetic diversity and environmental tolerance is developed. Algae and predators are periodically removed from the outplanted corals until they are firmly established on the reef. A stock population is maintained within the nursery to provide new colonies for outplanting. Corals can be attached directly to the reef or using attachment platforms like masonry nails or cement pucks. Outplanted corals can be wedged into holes or crevices, or secured using epoxy, cement, wire, or plastic ties.

In addition to the above activities for Port expansion, NMFS received a request for consultation dated August 26, 2013, from EPA to expand the ODMDS located offshore of Fort Lauderdale, Broward County, Florida (see Figure 3). NMFS has determined that this project is interrelated to and interdependent with the Port Evergaldes Expansion project, therefore it will be included in this Biological Opinion. The proposed project includes expanding the ODMDS from the existing 0.9 square nautical miles (nm^2) to an area of 3.21 nm^2, which will have a north-south oriented release zone. The Port Everglades Expansion project includes disposal of up to 5.47 million cubic yards (mcy) of dredged material within the ODMDS. The western edge of the site is located 3.3 nm offshore and the center of the site is located approximately 4 nm offshore. Water depths range from 604 to 735 ft. Previously collected sidescan sonar data (EPA 2004) and data collected from the OSV (Ocean Survey Vessel) Bold's site designation survey in May 2011 (ANAMAR 2012) indicate the bottom within the expansion area is primarily a homogenous mix of sand, silt, and clay with scattered rubble. There are approximately 12.85 acres of hardbottom within the expansion area; however, it is located below the 30-meter depth contour and is not considered critical habitat for any listed coral species, nor does it function as refuge habitat for sea turtles.

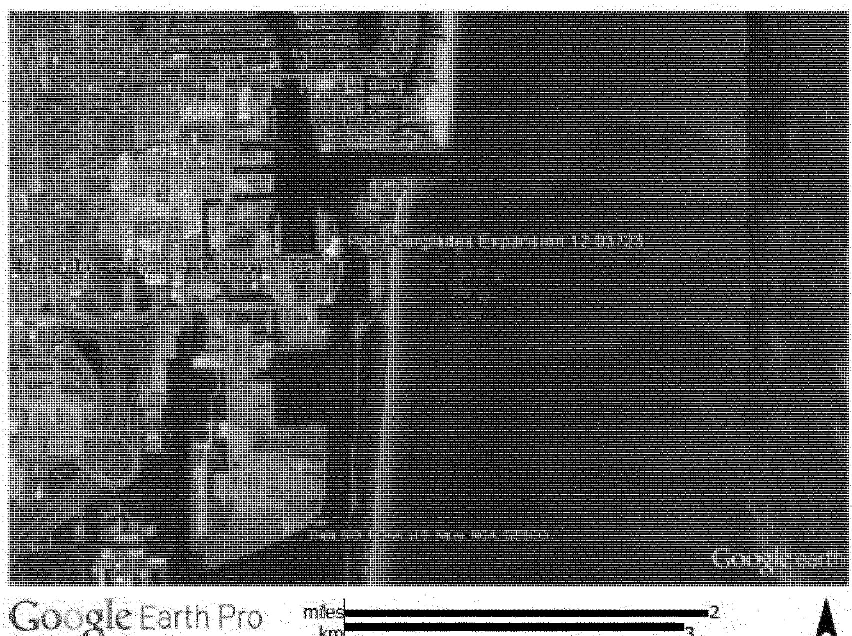

Figure 1. Location of Port Everglades Expansion project. Known colonies of *Acropora* corals are indicated in green.

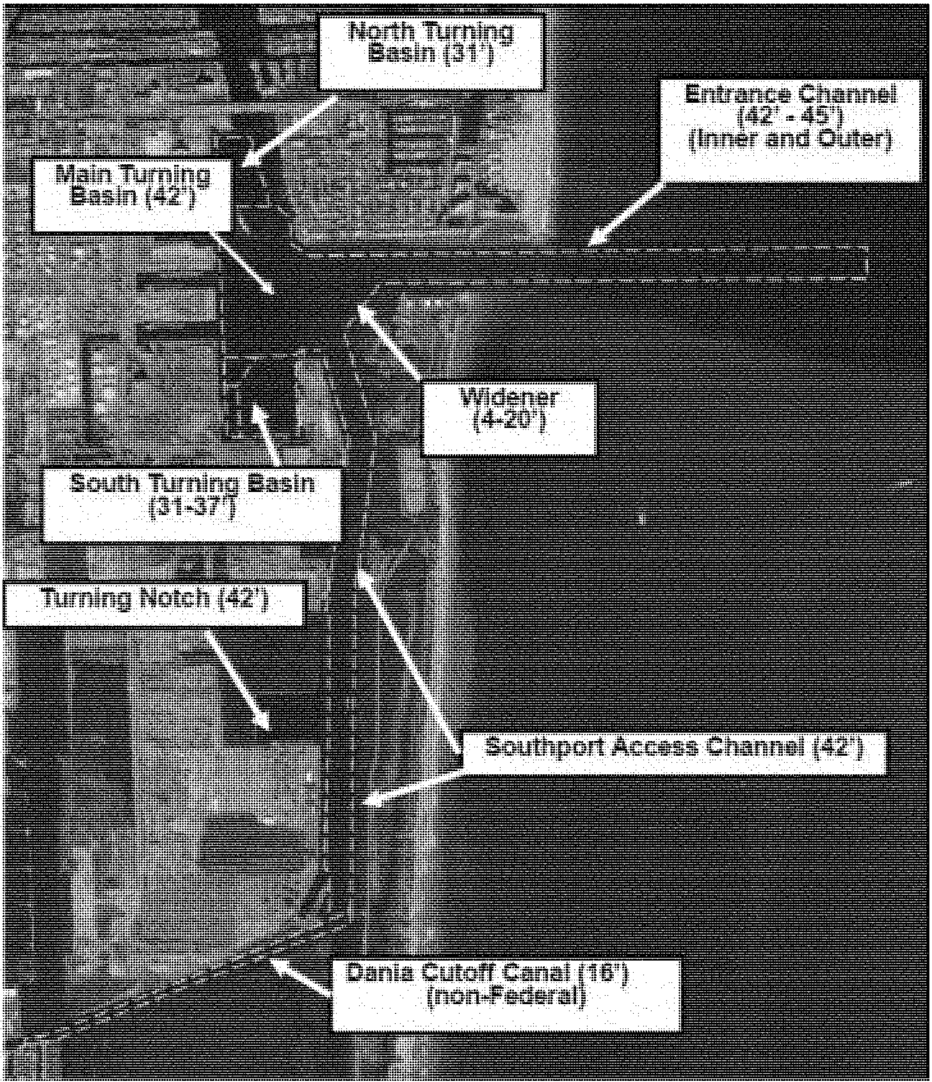

Figure 2. Port Everglades Expansion project components showing current depths. The Dania Cutoff Canal and the North Turning Basin are no longer part of the project (figure courtesy of USACE).

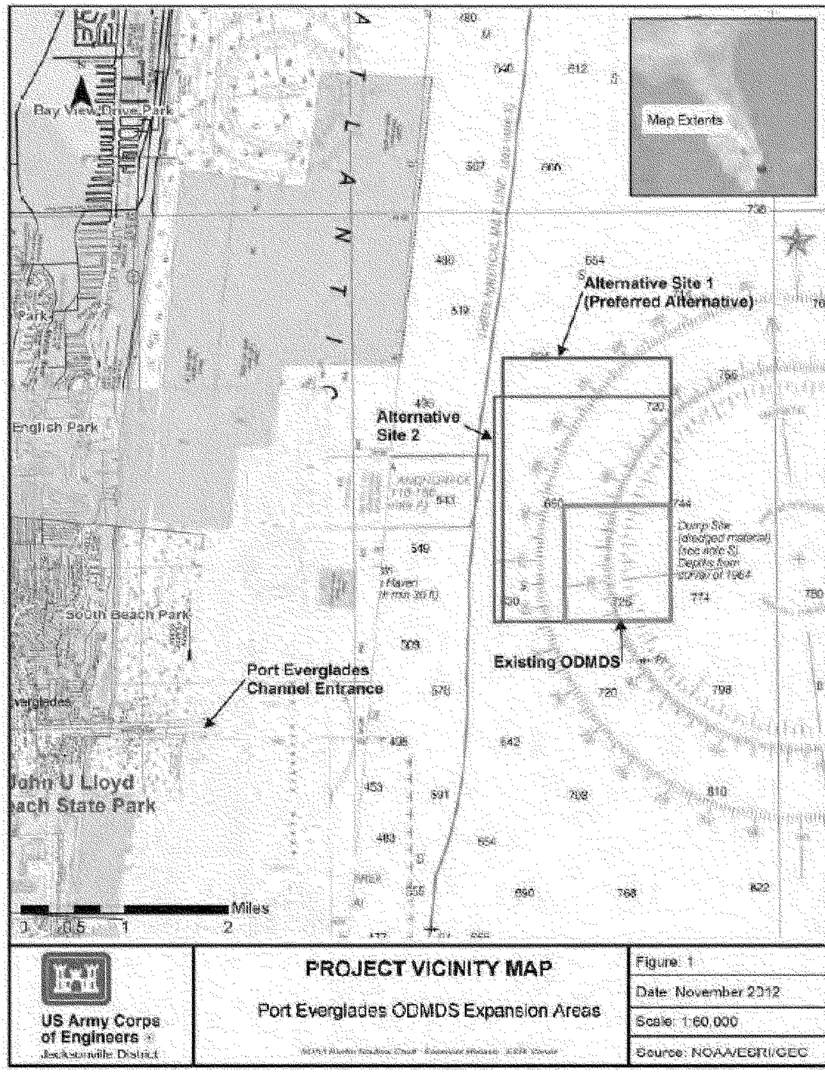

Figure 3. Location of EPA's ODMDS expansion project

3 Action Area

The action area is defined by regulation as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 CFR 402.02). The action area for this project includes the Port Everglades Harbor, which is located in Hollywood, Broward County, Florida. Port Everglades includes several areas within the Intracoastal Waterway and the access channel, which extends into the Atlantic Ocean. The action area also includes a 150-ft buffer zone surrounding the access channel, in which effects of dredging will likely occur. The action area also includes the spoil disposal sites, which consist of a site in the nearshore Atlantic Ocean off Broward County where the boulder mitigation reef will be created, the ODMDS in the Atlantic Ocean off Broward County, and the routes of vessel travel to and from the disposal sites. Last, the action area includes the coral nursery and outplanting sites within the Florida Reef Tract offshore.

4 Status of Listed Species and Critical Habitat

The following endangered (E), threatened (T), and proposed species (P), and designated critical habitat under the jurisdiction of NMFS may occur in or near the action area.

Table 1. Listed and Proposed Species and Critical Habitat Likely to Occur in or Near the Project Area

	Listed Species	
Common Name	Scientific Name	Status
	Turtles	
Green sea turtle	*Chelonia mydas*[1]	E/T
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
Leatherback sea turtle	*Dermochelys coriacea*	E
Loggerhead sea turtle	*Caretta caretta*[2]	T
Hawksbill sea turtle	*Eretmochelys imbricata*	E
	Fish	
Smalltooth sawfish	*Pristis pectinata*[3]	E
	Invertebrates and Marine Plants	
Staghorn coral	*Acropora cervicornis*	T; P-E[4]
Johnson's seagrass	*Halophila johnsonii*	T
	Marine Mammals	
Humpback whale	*Megaptera novaeangliae*	E
Sperm whale	*Physeter macrocephalus*	E
	Designated Critical Habitat	
Elkhorn/staghorn coral		
	Proposed Species	
Common Name	Scientific Name	Status
	Invertebrates	
Elliptical star coral	*Dichocoenia stokesii*	P-T[5]
Lamarck's sheet coral	*Agaricia lamarcki*	P-T
Rough cactus coral	*Mycetophyllia ferox*	P-E
Lobed star coral	*Orbicella annularis*	P-E
Mountainous star coral	*Orbicella faveolata*	P-E

[1] Green turtles are listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are listed as endangered.
[2] Northwest Atlantic Ocean (NWA) DPS.
[3] The U.S. DPS.
[4] *Acropora cervicornis* is currently listed as threatened and proposed for reclassification to endangered on December 7, 2012.
[5] All proposed corals were listed in the Federal Register on December 7, 2012.

Knobby star coral	*Orbicella franksi*	P-E
Proposed Critical Habitat		
Loggerhead sea turtle	Migratory and Breeding Habitat	Within Critical Habitat Unit Logg-N-19

4.1 Species and Critical Habitat Not Likely to be Adversely Affected

NMFS has analyzed the routes of potential project effects in the marine environment on 5 species of sea turtles (loggerhead, Kemp's ridley, leatherback, hawksbill, and green), smalltooth sawfish, humpback whales, and sperm whales from the proposed action. We have determined the potential routes of effects to sea turtles and smalltooth sawfish include (1) injury or death from potential interactions with and operation of dredges and blasting, and (2) avoidance of the area during construction operations due to disturbance caused by blasting, dredging, and placement of dredged materials in the various disposal sites (ODMDS, and the artificial reef mitigation site). Loss of foraging habitat within the dredge footprint could also affect sea turtles. The potential routes of effects to whales include injury or death from potential interactions with hopper dredges during dredging and disposal of dredged material in the ODMDS, injury or death from potential blasting, and temporary avoidance of areas during construction. Of these, only interactions with hopper dredges have the potential for adverse effects, and only for certain turtle species, as discussed below and in the Effects of the Action section.

Smalltooth Sawfish

Smalltooth sawfish are unlikely to be found within the existing channel area but may be found in the mangrove areas located at the western edge of John U. Lloyd State Park, although no sawfish have been reported. In the unlikely event a sawfish is present in the project area, sawfish should not be injured or killed by the dredging or construction activities because the dredges advance relatively slowly (the cutterhead dredges and mechanical-type dredges that are feasible to use in these areas are very slow, almost stationary) and are noisy, giving mobile sawfish the opportunity to get out of the way. Due to the sawfish's mobility, ability to detect the approaching draghead, and apparent avoidance behavior, the risk of injury will be discountable. While sea turtles are regularly taken by hopper dredges, apparently failing to react in time to avoid the overtaking draghead, possibly because they have limited hearing abilities at lower frequencies, no sawfish take by a dredge [of any type] has ever been reported to NMFS. The implementation of NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* may provide an additional measure of protection.

Sawfish may also be affected by blasting. Underwater explosions produce a pressure waveform with rapid oscillations from positive pressure to negative pressure that results in rapid volume changes in gas-containing organs. In fish, the swimbladder, a gas-containing organ, is the most frequently damaged organ (Christian 1973; Faulk and Lawrence 1973; Kearns and Boyd 1965; Linton et al. 1985a; Yelverton et al. 1975). It is subject to rapid contraction and overextension in response to the explosive shock waveform (Wiley et al. 1981). Species lacking swimbladders (like smalltooth sawfish) or with small swimbladders are highly resistant to explosive pressures (Aplin 1947; Fitch and Young 1948; Goertner 1994). For example, Wiley et al. (1981) and Goertner et al. (1994) noted that hogchokers (*Trinectes maculatus*), which lack swimbladders, were extremely tolerant of underwater explosions, and greatly exceeded the tolerance of any species with swimbladders that they had tested. The USACE will require the contractor to adhere to the above safety conditions related to blasting. Based on these measures and the sawfish's likely absence from the main channel areas, NMFS believes that the effects on sawfish from blasting will be discountable.

As previously noted, no sawfish have been reported and they are unlikely to be found within the existing channel area, but may be found in the mangrove areas located at the western edge of John U. Lloyd State Park. The dredging will remove approximately 1.2 acres of fringe mangroves along the east side of the existing channel. Even so, dredging near the mangrove area will only be for a portion of the overall project time. Dredging will occur a section at a time; time spent on each section depends on the amount of pre-treatment necessary and the amount of rock to be removed from each area. There is additional mangrove habitat (that will not be impacted) available directly adjacent to the project site and within the park. Smalltooth sawfish may be affected by being temporarily unable to use discreet sections affected by construction due to potential avoidance of construction activities, blasting, and related noise; however, disturbance from dredging activities and related noise in areas most likely to be used by sawfish will be intermittent, localized, and only for part of the construction period.

Like many elasmobranchs, juvenile smalltooth sawfish exhibit site fidelity to the areas in which they are pupped for the first several years of their lives, typically remaining in very shallow nearshore waters where they can avoid predation by coastal shark species. In South Florida, sawfish have established distinct nursery areas where they utilize shallow, euryhaline habitat and red mangroves for foraging and refuge; these areas have been designated as critical habitat for the species (discussed below), though NMFS expects that areas outside of the designated critical habitat are used by some sawfish for pupping and nursery habitat, where there is appropriate juvenile habitat. As noted, dredging will remove approximately 1.2 acres of fringe mangroves along the east side of the existing channel. Additional mangrove habitat exists directly adjacent to the impact area, along the west side of John U. Lloyd State Park (see Figure 4), which will be preserved. USACE will also install breaks in the riprap area to allow better access to these mangroves. NMFS believes that if juvenile sawfish are using the mangroves they are likely to be using the more suitable habitat inside the park; the 1.2 acres of fringe mangroves are in deeper waters directly adjacent to the shipping channel and as such are subject to constant traffic and pollutants. The continual vessel traffic and deeper water means these fringe mangroves are not the preferred habitat for juvenile sawfish, which prefer shallow (0-3 ft depth), undisturbed habitats. Therefore, we believe that habitat related effects on sawfish will be insignificant.

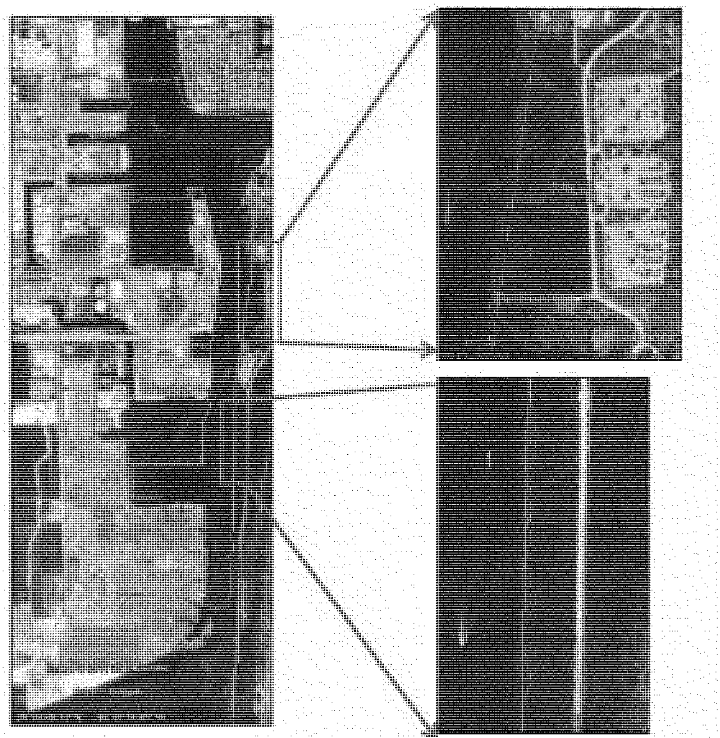

Figure 4. Mangrove impacts along the Southern Access Channel

Sea Turtles

Hydraulic and Mechanical Dredges

Large, hydraulic suction cutterhead dredges will be used to complete the deepening and widening of the channel. Smaller, mechanical clamshell-type ("bucket") dredges may also be used on portions of the project. NMFS believes the chance of injury or death from interactions with clamshell and/or hydraulic dredging equipment is discountable as these dredge types advance very slowly and sea turtles are highly mobile and are likely to avoid the areas during construction. NMFS has received very few reports of sea turtle takes associated with these dredging methods in the South Atlantic region: only 1 (live) sea turtle has been taken by a clamshell dredge over the past 33 years. The take occurred at Cape Canaveral, Florida, which routinely has very high local sea turtle abundance. Cold-stunned turtles have also been taken by cutterhead dredging, but this also rarely happens and has been generally limited to shallow, confined waters (e.g., Laguna Madre, Texas) or bays where turtles get trapped and stunned when the rapid passage of a cold front causes the temperature of the shallow water body to drop abruptly. Due to the infrequency of interactions with these gear types and the project location and channel depths, NMFS believes that the likelihood of cold stunning occurring is discountable and also that the possibility of a sea turtle being taken by a hydraulic cutterhead or a clamshell dredge is discountable.

Disposal Vessels

NMFS believes that the possibility that disposal vessel(s) will collide with and injure or kill sea turtles during disposal operations is discountable, given the vessels' slow speed (the fastest disposal scows travel at speeds of 12 knots or less (pers. comm. Terri Jordan-Sellers, USACE to Kelly Logan, NMFS, February 19, 2014), the ability of these species to move out of the way, and anticipated avoidance behavior by sea turtles at the sea surface or in the water column. Furthermore, NMFS believes the proposed dredged material (approximately 4.57 mcy) disposal activities over the life of the project are not likely to adversely affect sea turtles. Sea turtles may be attracted to ODMDS sites, to forage on the bycatch that may be occasionally found in the dredged material being dumped. As such, turtles could be potentially impacted by the sediments being discharged overhead. However, NMFS has never received a report of an injury to a sea turtle resulting from burial in, or impacts from, dredge disposal sediments, from inshore or offshore disposal sites, anywhere the USACE conducts dredged material disposal operations. Sea turtles are highly mobile and apparently are able to avoid descending dredged material discharged at the surface. NMFS believes the possibility of injury, or burial of normal, healthy sea turtles by dredged material disposal, is discountable.

Habitat Loss

Habitat effects to sea turtles include the loss of less than 8 acres of seagrass (4.67 of which is Johnson's seagrass) and some coral reef habitat. There is no nearshore hardbottom within the action area to attract foraging juvenile green turtles. However, there are some deeper reef areas within the expansion of the outer entrance channel that may contain sponges and crabs (foraged by hawksbill and loggerhead turtles, respectively). NMFS believes that foraging habitat for sea turtles is not likely a limiting factor in the action area, and thus the loss of potential seagrass and coral reef foraging habitat within the action area will have insignificant effects on sea turtles.

Blasting

Underwater explosions may affect marine life by causing death, injury, temporary threshold shifts (TTS or recoverable hearing loss), or behavioral reactions, depending on the distance an animal is located from a blast. An underwater explosion is composed of an initial shock wave, followed by a succession of oscillating bubble pulses. A shock wave is a compression wave that expands radially out from the detonation point of an explosion. At a distance from a detonation, the propagation of the shock wave may be affected by several components including the direct shock wave, the surface-reflected wave, the bottom-reflected wave, and the bottom-transmitted wave. The direct shock wave results in the peak shock pressure (compression) and the reflected wave at the air-water surface produces negative pressure (expansion). For an explosion with the same energy and at the same distance, an underwater blast is much more dangerous to animals than an air blast. The shock wave in air dissipates more rapidly and tends to be reflected at the body surface; in water the blast wave travels through the body and may cause internal injury to gas-filled organs due to impedance differences at the gas-liquid interface.

Explosions are known to injure and kill sea turtles (Duronslet et al. 1986, Gitschlag 1990, Gitschlag and Herczeg 1994, Klima et al. 1988, O'Keefe and Young 1984). NMFS studied the effects of offshore oil and gas structure removals using 23 kg (50 lb) of nitromethane (Klima et al. 1988). Caged loggerhead and Kemp's ridley sea turtles were placed at distances of 700 ft (213.4 m), 1,200 ft (365.8 m), 1,800 ft (548.6 m), and 3,000 ft (914.4 m) from the platform to be removed with explosives. The charges were placed inside platform pilings at a depth of 5 m below the mudline. Post-detonation, 4 sea turtles within1,000 ft of the explosion were unconscious, as well as an individual at 3,000 ft. Sea turtles were expected to have drowned if not recovered from the water following the detonation. All turtles exposed to the blast exhibited everted cloacas and vasodilation lasting 2-3 weeks.

The sea turtle ear appears to be adapted to both aerial and aquatic environments. Sea turtles have a primitive reptilian ear and are considered to be hearing generalists, having limited hearing abilities at lower frequencies. Although there is some variation in sea turtle hearing measurements between species and size classes (Ketten and Bartol 2006), the available data suggest that species of sea turtles are likely sensitive to frequencies from approximately 100 Hertz (Hz) to 2,000 Hz (Lenhardt 1994, Lenhardt et al. 1996, McCauley et al. 2000a and 2000b, Moein et al. 1994, O'Hara and Wilcox 1990), with greatest underwater hearing sensitivities below 1,000 Hz (Ketten and Bartol 2006). Confined underwater blasts generally produce pulses of sound at low frequencies of several Hz to a few kHz (Hall 2010). Therefore, confined blasting will likely be heard by sea turtles and may result in behavioral reactions. Behavioral reactions to the sound produced from explosions may be important if they occur in biologically important areas such as foraging areas, near nesting beaches during nesting season, or in developmental juvenile habitats. The action area is not located near any nesting beaches or known juvenile development habitats, therefore we believe that behavioral effects due to sounds produced by confined blasting will be insignificant.

For all turtle species, potential routes of effects from the use of blasting are not likely to result in adverse effects for the following reasons:

1. Blasting mitigative procedures as proposed by the USACE are detailed in Section 2. Test blasts will be performed prior to the actual project blasting. Observers will also be stationed to observe for endangered species prior to test and project blasts. Test blasts are expected to cause sea turtles to leave the project area with, at most, insignificant behavioral modifications.

2. Studies have shown that stemmed blasts have up to a 60% to 90% decrease in the strength of the pressure wave released, compared to open-water blasts of the same charge weight (Hempen et al. 2007; Hempen et al. 2005; Nedwell and Thandavamoorthy 1992). However, unlike open-water blasts, very little documentation exists on the effects that confined blasting can have on marine animals near the blast (Keevin et al. 1999). The blast mitigation procedures detailed above, in particular the rigorous observer program, have been successfully used in several recent USACE projects (i.e., San Juan Harbor, Puerto Rico, in 1994, Miami Harbor in 2005, and Wilmington Harbor in 2012).

Since these procedures have been successfully used in several recent projects without incident, it is our continued judgment that they provide sufficient protections to sea turtles, and thus the effects from blasting are discountable.

Hopper Dredge Vessel Collisions
NMFS believes that the possibility that the hopper dredge vessel(s) will collide with and injure or kill sea turtles during dredging and/or sand pumpout operations is discountable, given the vessel's slow speed, the ability of these species to move out of the way, and anticipated avoidance behavior by sea turtles at the sea surface or in the water column.

Hopper Dredge Entrainment Effects
Leatherback Sea Turtles
NMFS believes the potential use of a hopper dredge may affect, but is not likely to adversely affect, leatherback sea turtles. Leatherback sea turtles tend to be open ocean, pelagic foragers and are uncommon in shallow nearshore waters, except during nesting season or during times when they may come in towards shore to feed on aggregations of jellyfish. The project area is not located near any nesting beaches. There has never been a reported take of a leatherback by a hopper dredge. The typical leatherback would be as large as or larger than the large, industry-standard California-type hopper dredge trailing-suction draghead, making leatherbacks unlikely to be entrained. Additionally, the California-type draghead design and level position during dredging (as opposed to more upright positioning of other dredge types), makes it less likely to entrain larger sea turtles (Studt 1987). Lastly, in over 32 years of observer-monitored hopper dredging projects in Jacksonville District, only 1 leatherback was ever been reported as lethally taken or observed, and that was in a relocation trawl. Relocation trawling is not proposed for this project. Based on the above, we believe that the risk of hopper dredging effects on leatherback sea turtles will be discountable. Leatherback sea turtles will not be discussed further in this opinion.

Hawksbill Sea Turtles
Hawksbill sea turtle nesting occurs in Puerto Rico, the U.S. Virgin Islands, and along the southeast coast of Florida. Outside of the nesting areas, hawksbills have been seen off the U.S. Gulf of Mexico states and along the Eastern Seaboard as far north as Massachusetts, although sightings north of Florida are rare (NMFS and USFWS 1993). They are closely associated with coral reefs and other hardbottom habitats, but they are also found in other habitats including inlets, bays, and coastal lagoons (NMFS and USFWS 1993). The hawksbill's diet is highly specialized and consists primarily of sponges (Meylan 1999). During the past 20 years of NMFS consultations with the USACE on hopper dredging projects carried out in the Palm Beach Harbor, Port Everglades, Port of Miami, and Key West areas there has never been a documented take of a hawksbill sea turtle by a hopper dredge.[6] Due to hawksbill sea turtles' preferred habitat and diet, it is not expected that interactions would occur in the action area; therefore, NMFS believes the possibility that they would be adversely affected by hopper dredge is discountable. Hawksbill sea turtles will not be considered further in this opinion.

Kemp's Ridley Sea Turtles

[6] http://el.erdc.usace.army.mil/seaturtles/index.cfm

NMFS believes the routes of effects from the potential use of a hopper dredge may affect, but are not likely to adversely affect, Kemp's ridley sea turtles because they have not been encountered during the past 20 years of hopper dredging activities in Palm Beach Harbor, Port Everglades, Port of Miami, or Key West. This species has a very restricted range relative to other sea turtle species with most adults occurring in the Gulf of Mexico in shallow near shore waters, although adult-sized individuals sometimes are found on the eastern seaboard of the United States as well. Nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in the Mexican state of Tamaulipas, although few nests have also been recorded in Florida and the Carolinas (Meylan et al. 1995). Atlantic juveniles/subadults travel northward with vernal warming to feed in the productive, coastal waters of Georgia through New England, returning southward with the onset of winter to escape the cold (Henwood and Ogren 1987, Lutcavage and Musick 1985, Ogren 1989). Upon leaving Chesapeake Bay in autumn, juvenile ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus 1997). These larger juveniles are joined there by juveniles of the same size from North Carolina sounds and smaller juveniles from New York and New England to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Epperly et al. 1995c, Epperly et al. 1995b, Musick and Limpus 1997). Adult Kemp's ridleys primarily occupy neritic habitats, typically containing muddy or sandy bottoms where prey can be found. In the post-pelagic stages, Kemp's ridley sea turtles are largely cancrivorous (crab eating), with a preference for portunid (swimming) crabs (Bjorndal 1997). Stomach contents of Kemp's ridleys along the lower Texas coast consisted of a predominance of nearshore crabs and mollusks, as well as fish, shrimp, and other foods considered to be scavenged discards from the shrimping industry (Shaver 1991). Kemp's ridley sea turtles will not be considered further in this opinion based on the improbability of their presence in the action area and a low likelihood of an encounter with a hopper dredge.

Humpback Whales

Humpback whales may be found in or near the action area. These species are generally found seaward of the continental shelf, and would only be in the action area during migrations to and from breeding grounds (during the spring and fall months). NMFS has analyzed the routes of potential effects on humpback whales from the proposed action and, based on our analysis, determined that potential effects are limited to the following: injury from potential interactions with construction equipment (e.g., a dredge vessel striking a whale), injury from use of explosives, and temporary avoidance of the area during construction operations. The USACE will require the contractor to follow the aforementioned blasting safety conditions. Blasting would result in temporary impacts and would not be a daily occurrence of the project. In addition, whales do not use this area throughout the year and would most likely be migrating, the USACE would not be blasting during a large portion of the year (November through March), as per the requirements to avoid harm to manatees listed above. Therefore, NMFS concludes that the project's blasting effects are discountable.

In addition, the dredge crew and contractors will be required to abide by NMFS's *Vessel Strike Avoidance and Reporting Guidelines* (Appendix A) and all dredges will be required to have NMFS-approved endangered species observers aboard. NMFS believes that the possibility that the disposal vessel(s) will collide with and injure or kill whales during disposal operations is discountable, given the vessel's slow speed (the fastest disposal scows travel at speeds of 12 knots or less (pers. comm. Terri Jordan-Sellers, USACE to Kelly Logan, NMFS, February 19, 2014), and the whales' limited, seasonal presence in the action area. With implementation of these conservation measures, NMFS believes that the likelihood of a dredge or disposal vessel striking a humpback whale is discountable.

Sperm Whales
Sperm whales are predominantly found seaward of the continental shelf and are not expected to be found within the shallow waters inshore of the outer reef nor at the ODMDS. Therefore, we believe the risk to sperm whales from blasting or dredging impacts, including potential collision with a dredge vessel en route to or from the ODMDS, is discountable.

Proposed Critical Habitat for Loggerhead Sea Turtles
While a portion of the project occurs in proposed critical habitat for loggerheads, specifically unit Logg-N-19, which includes concentrated breeding habitat and constricted migratory corridor habitat, the project is not expected to impact the primary constituent elements (PCEs) and thus the habitat itself. The PCEs that support breeding habitat are (1) high concentrations of reproductive male and female loggerheads; (2) proximity to primary Florida migratory corridor; and (3) proximity to Florida nesting grounds. The PCEs for constricted migratory habitat are (1) constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and (2) passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas. Dredging and port expansion will not alter the PCEs for breeding habitat as it will not impact the high concentration of reproductive individuals in the area nor the proximity to the nesting grounds or migratory corridor. The PCEs for the constricted migratory corridor will not be impacted as the project will not alter the passage conditions of the corridor. Therefore, effects to loggerhead critical habitat as it is currently proposed are discountable.

4.2 Species and Critical Habitat Likely to be Adversely Affected
NMFS believes that the proposed project may affect green and loggerhead sea turtles, Johnson's seagrass, staghorn coral, 6 coral species proposed to be listed, and elkhorn and staghorn coral-designated critical habitat.

4.2.1 Sea Turtles
The following subsections are synopses of the best available information on the status of the sea turtle species that are likely to be adversely affected by 1 or more components of the proposed action, including information on the distribution, population structure, life history, abundance, and population trends of each species and threats to each species. The biology and ecology of these species as well as their status and trends inform the effects analysis for this opinion. Additional background information on the status of sea turtle species can be found in a number of published documents, including: recovery plans for the Atlantic green sea turtle (NMFS and USFWS 1991), and loggerhead sea turtle (NMFS and USFWS 2008a); Pacific sea turtle recovery plans (NMFS and USFWS 1998a; NMFS and USFWS 1998b; NMFS and USFWS 1998c; NMFS and USFWS 1998b); and sea turtle status reviews, stock assessments, and biological reports (Conant et al. 2009; NMFS-SEFSC 2001; NMFS-SEFSC 2009a; NMFS and USFWS 1995b; NMFS and USFWS 2007a; NMFS and USFWS 2007b; NMFS and USFWS 2007c;

NMFS and USFWS 2007d; NMFS and USFWS 2007e; TEWG 1998; TEWG 2000a; TEWG 2007; TEWG 2009).

4.2.1.1 General Threats Faced by All Sea Turtle Species

Sea turtles face numerous natural and anthropogenic threats that shape their status and affect their ability to recover. As many of the threats are the same or similar in nature for all listed sea turtle species, those identified in this section are discussed in a general sense for all listed sea turtles. Threat information specific to a particular species is then discussed in the corresponding status section where appropriate.

Fisheries

Incidental bycatch in commercial fisheries is identified as a major contributor to past declines, and threat to future recovery, for all of the sea turtle species (NMFS and USFWS 1991, 1992, 1993, 2008, 2011). Domestic fisheries often capture, injure, and kill sea turtles at various life stages. Sea turtles in the pelagic environment are exposed to U.S. Atlantic pelagic longline fisheries. Sea turtles in the benthic environment in waters off the coastal United States are exposed to a suite of other fisheries in federal and state waters. These fishing methods include trawls, gillnets, purse seines, hook-and-line gear [including bottom longlines and vertical lines (e.g., bandit gear, handlines, and rod-reel)], pound nets, and trap fisheries. (Refer to the Environmental Baseline section of this opinion for more specific information regarding federal and state managed fisheries affecting sea turtles within the action area). The Southeast shrimp fisheries have historically been the largest fishery threat to benthic sea turtles in the southeastern United States, and continue to interact with and kill large numbers of sea turtles each year.

In addition to domestic fisheries, sea turtles are subject to direct as well as incidental capture in numerous foreign fisheries, further impeding the ability of sea turtles to survive and recover on a global scale. For example, pelagic stage sea turtles, especially loggerheads and leatherbacks, circumnavigating the Atlantic are susceptible to international longline fisheries including the Azorean, Spanish, and various other fleets (Aguilar et al. 1995; Bolten et al. 1994; Crouse 1999). Bottom longline and gillnet fishing are known to occur in many foreign waters, including (but not limited to) the northwest Atlantic, western Mediterranean, South America, West Africa, Central America, and the Caribbean. Shrimp trawl fisheries are also operating off the shores of numerous foreign countries and pose a significant threat to sea turtles similar to the impacts seen in U.S. waters. Many unreported takes or incomplete records by foreign fleets make it difficult to characterize the total impact that international fishing pressure is having on listed sea turtles. Nevertheless, international fisheries represent a continuing threat to sea turtle survival and recovery throughout their respective ranges.

Non-Fishery In-Water Activities

There are also many non-fishery impacts affecting the status of sea turtle species, both in the ocean and on land. In nearshore waters of the United States, the construction and maintenance of federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly and can entrain and kill sea turtles (NMFS 1997a). Sea turtles entering coastal or inshore areas have also been affected by entrainment in the cooling-water systems of electrical generating plants. Other nearshore threats include harassment and/or injury resulting from private and commercial vessel operations, military detonations and training exercises, in-water construction activities, and scientific research activities.

Coastal Development and Erosion Control
Coastal development can deter or interfere with nesting, affect nesting success, and degrade nesting habitats for sea turtles. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997). These factors may decrease the amount of nesting area available to females and change the natural behaviors of both adults and hatchlings, directly or indirectly, through loss of beach habitat or changing thermal profiles and increasing erosion, respectively. (Ackerman 1997; Witherington et al. 2003; Witherington et al. 2007). In addition, coastal development is usually accompanied by artificial lighting which can alter the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings that are drawn away from the water (Witherington and Bjorndal 1991). In-water erosion control structures such as breakwaters, groins, and jetties can impact nesting females and hatchlings as they approach and leave the surf zone or head out to sea by creating physical blockage, concentrating predators, creating longshore currents, and disrupting of wave patterns.

Environmental Contamination
Multiple municipal, industrial, and household sources, as well as atmospheric transport, introduce various pollutants such as pesticides, hydrocarbons, organochlorides (e.g., DDT, PCBs, and PFCs), and others that may cause adverse health effects to sea turtles (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 1993). Acute exposure to hydrocarbons from petroleum products released into the environment via oil spills and other discharges may directly injure individuals through skin contact with oils (Geraci 1990), inhalation at the water's surface and ingesting compounds while feeding (Matkin and Saulitis 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area. In 2010, there was a massive oil spill in the Gulf of Mexico at BP's Macondo well. Official estimates are that millions of barrels of oil were released into the Gulf of Mexico. Additionally, approximately 1.8 million gallons of chemical dispersant were applied on the seawater surface and at the wellhead to attempt to break down the oil. At this time the assessment of total direct impact to sea turtles has not been determined. Additionally, we do not know the long-term impacts to sea turtles because of habitat impacts, prey loss, and subsurface oil particles and oil components broken down through physical, chemical, and biological processes.

Marine debris is a continuing problem for sea turtles. Sea turtles living in the pelagic environment commonly eat or become entangled in marine debris (e.g., tar balls, plastic bags/pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts where debris and their natural food items converge. This is especially problematic for sea turtles that spend all or significant portions of their life cycle in the pelagic environment (i.e., leatherbacks, juvenile loggerheads, and juvenile green turtles).

Climate Change
There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. NOAA's climate information portal provides basic background information on these and other measured or anticipated effects (see http://www.climate.gov).

Climate change impacts on sea turtles currently cannot be predicted with any degree of certainty; however, significant impacts to the hatchling sex ratios of sea turtles may result (NMFS and USFWS 2007c). In sea turtles, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25°-35°C (Ackerman 1997). Increases in global temperature could potentially skew future sex ratios toward higher numbers of females (NMFS and USFWS 2007c).

The effects from increased temperatures may be intensified on developed nesting beaches where shoreline armoring and construction have denuded vegetation. Erosion control structures could potentially result in the permanent loss of nesting beach habitat or deter nesting females (NRC 1990). These impacts will be exacerbated by sea level rise. If females nest on the seaward side of the erosion control structures, nests may be exposed to repeated tidal overwash (NMFS and USFWS 2007c). Sea level rise from global climate change is also a potential problem for areas with low-lying beaches where sand depth is a limiting factor, as the sea may inundate nesting sites and decrease available nesting habitat (Baker et al. 2006; Daniels et al. 1993; Fish et al. 2005). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis et al. 2006; Baker et al. 2006).

Other changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution, etc.) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish, etc.) which could ultimately affect the primary foraging areas of sea turtles.

Other Threats
Predation by various land predators is a threat to developing nests and emerging hatchlings. The major natural predators of sea turtle nests are mammals, including raccoons, dogs, pigs, skunks, and badgers. Emergent hatchlings in the United States are preyed upon by these mammals as well as ghost crabs, laughing gulls, and the exotic South American fire ant (*Solenopsis invicta*). In addition to natural predation, direct harvest of eggs and adults from beaches in foreign countries continues to be a problem for various sea turtle species throughout their ranges (NMFS and USFWS 2008a).

Diseases, toxic blooms from algae and other microorganisms, and cold stunning events are additional sources of mortality that can range from local and limited to wide-scale and impacting hundreds or thousands of animals.

Actions Taken to Reduce Threats
Actions have been taken to reduce anthropogenic impacts to sea turtles from various sources, particularly since the early 1990s. These include lighting ordinances, predation control, and nest relocations to help increase hatchling survival, as well as measures to reduce the mortality of pelagic immatures, benthic immatures, and sexually mature age classes from various fisheries and other marine activities. Some actions have resulted in significant steps towards reducing the recurring sources of mortality of sea turtles in the environmental baseline and improving the status of all sea turtle populations in the Atlantic and Gulf of Mexico. For example, the TED regulation published on February 21, 2003 (68 FR 8456), represent a significant improvement in the baseline effects of trawl fisheries on sea turtles, though shrimp trawling is still considered to be one of the largest source of anthropogenic mortality for most of our sea turtle species (NMFS-SEFSC 2009a).

4.2.1.2 Loggerhead Sea Turtle – Northwest Atlantic DPS
The loggerhead sea turtle was listed as a threatened species throughout its global range on July 28, 1978. NMFS and USFWS subsequently published a final rule listing 9 DPSs of loggerhead sea turtles (76 FR 58868, September 22, 2011, effective October 24, 2011). The DPSs established by this rule include (1) Northwest Atlantic Ocean (threatened), (2) Northeast Atlantic Ocean (endangered), (3) South Atlantic Ocean (threatened), (4) Mediterranean Sea (endangered), (5) North Pacific Ocean (endangered), (6) South Pacific Ocean (endangered), (7) North Indian Ocean (endangered), (8) Southeast Indo-Pacific Ocean (endangered), and (9) Southwest Indian Ocean (threatened). The Northwest Atlantic Ocean (NWA) DPS is the only 1 that occurs within the action area and therefore is the only one considered in this Opinion. NMFS has proposed to designate critical habitat for the NWA DPS of loggerhead sea turtles. Specific areas proposed for designation include 36 occupied marine areas within the range of the NWA DPS. These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors. The rule is scheduled to be finalized in July 2014.

Species Description and Distribution
Loggerheads are large sea turtles with the mean straight carapace length (SCL) of adults in the southeast United States being approximately 3 ft (92 cm). The corresponding mass is approximately 255 lb (116 kg) (Ehrhart and Yoder 1978). Adult and subadult loggerhead sea turtles typically have a light yellow plastron and a reddish brown carapace covered by non-overlapping scutes that meet along seam lines. They typically have 11 or 12 pairs of marginal scutes, 5 pairs of costals, 5 vertebrals, and a nuchal (precentral) scute that is in contact with the first pair of costal scutes (Dodd 1988).

The loggerhead sea turtle inhabits continental shelf and estuarine environments throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd 1988). Habitat uses within these areas vary by life stage. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish and vegetation at or near the surface (Dodd 1988). Subadult and adult loggerheads are primarily found in coastal waters and prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

The majority of loggerhead nesting occurs at the western rims of the Atlantic and Indian Oceans concentrated in the north and south temperate zones and subtropics (NRC 1990). In the western North Atlantic, loggerhead nesting is concentrated along the coasts of the United States from southern Virginia to Alabama. Additional nesting beaches are found along the northern and western Gulf of Mexico, eastern Yucatán Peninsula, at Cay Sal Bank in the eastern Bahamas (Addison 1997; Addison and Morford 1996), off the southwestern coast of Cuba (Gavilan 2001), and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands.

Non-nesting, adult female loggerheads are reported throughout the United States and Caribbean Sea. Little is known about the distribution of adult males, which are seasonally abundant near nesting beaches. However, aerial surveys suggest that the general species distribution of loggerheads in U.S. waters is as follows: 54% in the Atlantic off the southeast United States, Atlantic, 29% in the Atlantic off the northeast United States, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Within the NWA, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf coast of Florida. NMFS has previously recognized at least 5 Western Atlantic subpopulations based on nesting beach assemblages, divided geographically as follows:

(1) a Northern nesting subpopulation, occurring from North Carolina to Northeast Florida at about 29°N;

(2) a South Florida nesting subpopulation, occurring from 29°N on the east coast of the state to Sarasota on the west coast;

(3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida;

(4) a Yucatán nesting subpopulation, occurring on the Eastern Yucatán Peninsula, Mexico (Márquez M 1990; TEWG 2000a); and

(5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS-SEFSC 2001).

The recovery plan for the Northwest Atlantic population of loggerhead sea turtles concluded, based on recent advances in genetic analyses, that there is no genetic distinction between loggerheads nesting on adjacent beaches along the Florida Peninsula and that specific boundaries for subpopulations could not be designated based on genetic differences alone. Thus, the plan uses a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to identify recovery units. The recovery units are (1) the Northern Recovery Unit (Florida/Georgia border north through southern Virginia), (2) the Peninsular Florida Recovery Unit (Florida/Georgia border through

Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (Franklin County, Florida, through Texas), and (5) the Greater Caribbean Recovery Unit (Mexico through French Guiana, the Bahamas, Lesser Antilles, and Greater Antilles) (NMFS and USFWS 2008a). The recovery plan concluded that all recovery units are essential to the recovery of the species. Although the recovery plan was written prior to the listing of the NWA DPS, the recovery units for what was then termed the Northwest Atlantic population apply to the NWA DPS.

Life History Information
The Northwest Atlantic Loggerhead Recovery Team defined the following 8 life stages for the loggerhead life cycle, including the ecosystems those stages generally use: (1) egg (terrestrial zone), (2) hatchling stage (terrestrial zone), (3) hatchling swim frenzy and transitional stage (neritic zone[7]), (4) juvenile stage (oceanic zone), (5) juvenile stage (neritic zone), (6) adult stage (oceanic zone), (7) adult stage (neritic zone), and (8) nesting female (terrestrial zone) (NMFS and USFWS 2008). Loggerheads are long-lived organisms that reach sexual maturity between 20 and 38 years of age, although this varies widely among populations (Frazer and Ehrhart 1985; NMFS and SEFSC 2001). The annual mating season for loggerhead sea turtles occurs from late March to early June, and eggs are laid throughout the summer months. Female loggerheads deposit an average of 4.1 nests within a nesting season (Murphy and Hopkins 1984) but an individual female only nests every 3.7 years on average (Tucker 2010). Along the southeastern United States, loggerheads lay an average of 100 to 126 eggs per nest (Dodd 1988) which incubate for 42 to 75 days before hatching (NMFS and USFWS 2008b).

As post-hatchlings, loggerheads hatched on U.S. beaches migrate offshore and become associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986), (Witherington 2002). Loggerheads originating from the NWA DPS are believed to lead a pelagic existence in the North Atlantic Gyre for a period as long as 7-12 years (Bolten et al. 1998) before moving to more coastal habitats. Recent studies have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic juveniles, followed by permanent settlement into benthic environments (Bolten and Witherington 2003; Laurent et al. 1998). These studies suggest some turtles may either remain in the pelagic habitat in the North Atlantic longer than hypothesized or move back and forth between pelagic and coastal habitats interchangeably (Witzell 2002). Stranding records indicate that when immature loggerheads reach 15-24 inches (40-60 cm) SCL, they begin to occur in coastal inshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico (Witzell 2002).

After departing the oceanic zone, neritic juvenile loggerheads in the Northwest Atlantic inhabit continental shelf waters from Cape Cod Bay, Massachusetts, south through Florida, The Bahamas, Cuba, and the Gulf of Mexico. Estuarine waters of the United States, including areas such as Long Island Sound, Chesapeake Bay, Pamlico and Core Sounds, Mosquito and Indian River Lagoons, Biscayne Bay, Florida Bay, and numerous embayments fringing the Gulf of Mexico, comprise important inshore habitat. Along the Atlantic and Gulf of Mexico shoreline, essentially all shelf waters are inhabited by loggerheads.

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[7] Neritic refers to the inshore marine environment from the surface to the sea floor where water depths do not exceed 200 meters.

Like juveniles, non-nesting adult loggerheads also use the neritic zone. However, these adult loggerheads use the relatively enclosed shallow-water estuarine habitats with limited ocean access are less frequently than the juveniles. Juveniles, but not adult loggerheads, regularly use areas such as Pamlico Sound, North Carolina, and the Indian River Lagoon, Florida. In comparison, adult loggerheads tend to use estuarine areas with more open ocean access, such as Chesapeake Bay in the U.S. Mid-Atlantic. Shallow-water habitats with large expanses of open ocean access, such as Florida Bay, provide year-round resident foraging areas for significant numbers of male and female adult loggerheads. Offshore, adults primarily inhabit continental shelf waters, from New York south through Florida, The Bahamas, Cuba, and the Gulf of Mexico. Seasonal use of Mid-Atlantic shelf waters, especially offshore New Jersey, Delaware, and Virginia during summer months, and offshore shelf waters, such as Onslow Bay (off the North Carolina coast), during winter months has also been documented (Hawkes et al. 2007a; Georgia Department of Natural Resources, unpublished data; South Carolina Department of Natural Resources, unpublished data). Satellite telemetry has identified the shelf waters along the west Florida coast, The Bahamas, Cuba, and the Yucatán Peninsula as important resident areas for adult female loggerheads that nest in Florida (Foley et al. 2008; M. Lamont, Florida Cooperative Fish and Wildlife Research Unit, personal communication, 2009; M. Nicholas, National Park Service, personal communication, 2009). The southern edge of the Grand Bahama Bank is important habitat for loggerheads nesting on the Cay Sal Bank in The Bahamas, but nesting females are also resident in the bights of Eleuthera, Long Island, and Ragged Islands as well as Florida Bay in the United States, and the north coast of Cuba (A. Bolten and K. Bjorndal, University of Florida, unpublished data). Moncada et al. (2009) report the recapture in Cuban waters of 5 adult female loggerheads originally flipper tagged in Quintana Roo, Mexico, indicating that Cuban shelf waters likely also provide foraging habitat for adult females that nest in Mexico.

Status and Population Dynamics

A number of stock assessments and similar reviews (Conant et al. 2009; Heppell et al. 2003a; NMFS-SEFSC 2009a; NMFS and SEFSC 2001; NMFS and USFWS 2008a; TEWG 1998; TEWG 2000a; TEWG 2009) have examined the stock status of loggerheads in the Atlantic Ocean, but none have been able to develop a reliable estimate of absolute population size.

Numbers of nests and nesting females can vary widely from year to year. However, nesting beach surveys can provide a reliable assessment of trends in the adult female population, due to the strong nest site fidelity of female loggerhead sea turtles, as long as such studies are sufficiently long and effort and methods are standardized [see, e.g., NMFS and USFWS (2008a)]. NMFS and USFWS (2008a) concluded that the lack of change in two important demographic parameters of loggerheads, remigration interval and clutch frequency, indicate that time series on numbers of nests can provide reliable information on trends in the female population.

<u>Peninsular Florida Recovery Unit</u>

The Peninsular Florida Recovery Unit (PFRU) is the largest loggerhead nesting assemblage in the Northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989 to 2007 showed a mean of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females per year (NMFS and USFWS 2008a). The statewide estimated total for 2012 was 98,601 nests (FWRI nesting database).

In addition to the total nest count estimates, the Florida Fish and Wildlife Research Institute (FWRI) uses an index nesting beach survey method. The index survey uses standardized data-collection criteria to measure seasonal nesting and allow accurate comparisons between beaches and between years. This provides a better tool for understanding the nesting trends (Figure 5). FWRI performed a detailed analysis of the long-term loggerhead index nesting data (1989-2012) (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/). Three distinct trends over that time period were identified. From 1989-1998 there was a 23% increase, that was then followed by a sharp decline over the subsequent decade. However, recent large increases in loggerhead nesting occurred since then. FWRI examined the trend from the 1998 nesting high through 2012 and found the decade-long post-1998 decline had reversed and there was no longer a demonstrable trend. Looking at the data from 1989 through 2012 FWRI concluded that there was an overall positive change in the nest counts.

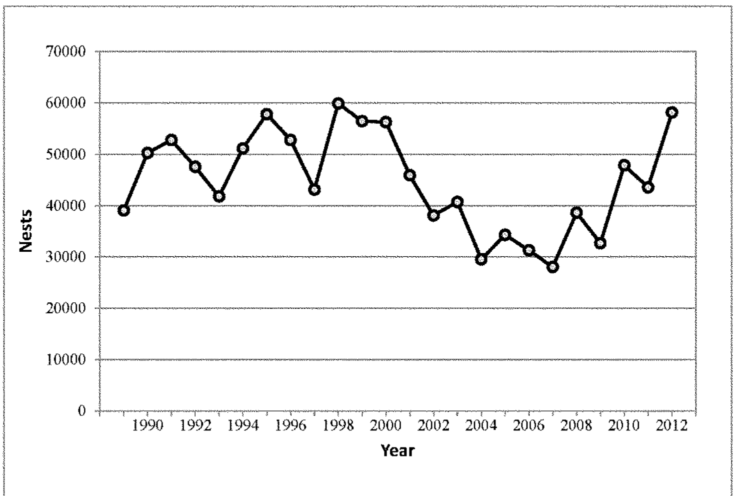

Figure 5. Loggerhead sea turtle nesting at Florida index beaches since 1989

Northern Recovery Unit

Annual nest totals from beaches within the Northern Recovery Unit (NRU) averaged 5,215 nests from 1989-2008, a period of near-complete surveys of NRU nesting beaches (Georgia Department of Natural Resources (GDNR) unpublished data, North Carolina Wildlife Resources Commission (NCWRC) unpublished data, South Carolina Department of Natural Resources (SCDNR) unpublished data), and represent approximately 1,272 nesting females per year, assuming 4.1 nests per female (Murphy and Hopkins 1984). The loggerhead nesting trend from daily beach surveys showed a significant decline of 1.3% annually from 1989-2008. Nest totals from aerial surveys conducted by SCDNR showed a 1.9% annual decline in nesting in South

Carolina from 1980 through 2008. Overall, there is strong statistical data to suggest the NRU had experienced a long-term decline over that period.

Data since that analysis (Table 2) are showing improved nesting numbers and a departure from the declining trend. Georgia nesting has rebounded to show the first statistically significant increasing trend since comprehensive nesting surveys began in 1989 (Mark Dodd, GADNR press release, http://www.georgiawildlife.com/node/3139). South Carolina and North Carolina nesting have also begun to show a shift away from the past declining trend.

Table 2. Total Number of NRU Loggerhead Nests (GADNR, SCDNR, and NCWRC Nesting Datasets)

Nests Recorded	2008	2009	2010	2011	2012
Georgia	1,649	997	1,761	1,992	2,218
South Carolina	4,500	2,183	3,141	4,015	4,615
North Carolina	841	276	846	948	1,069
Total	6,990	3,456	5,748	6,955	7,902

South Carolina also conducts an index beach nesting survey similar to the one described for Florida. Although the survey only includes a subset of nesting, the standardized effort and locations allow for a better representation of the nesting trend over time. Increases in nesting were seen for the period from 2009-2012, with 2012 showing the highest index nesting total since the start of the program (Figure 6).

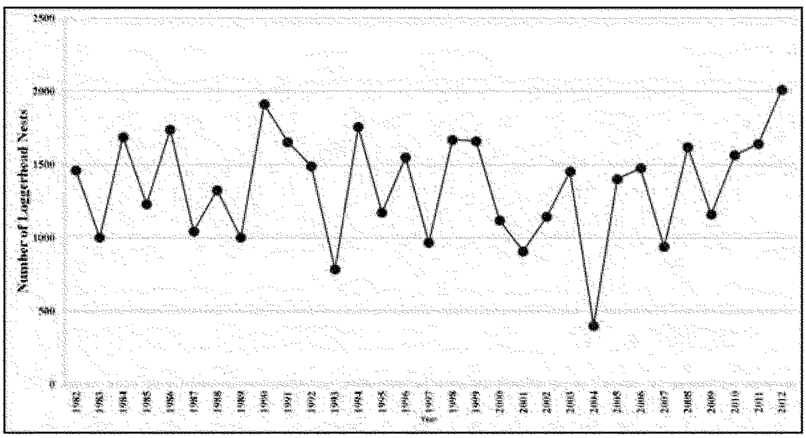

Figure 6. South Carolina index nesting beach counts for loggerhead sea turtles (from the SCDNR website, http://www.dnr.sc.gov/seaturtle/nest.htm)

<u>Other Northwest Atlantic DPS Recovery Units</u>

The remaining 3 recovery units—Dry Tortugas (DTRU), Northern Gulf of Mexico (NGMRU), and Greater Caribbean (GCRU)—are much smaller nesting assemblages but still considered essential to the continued existence of the species. Nesting surveys for the DTRU are conducted as part of Florida's statewide survey program. Survey effort was relatively stable during the 9-year period from 1995-2004 (although the 2002 year was missed). Nest counts ranged from 168-270, with a mean of 246, but with no detectable trend during this period (NMFS and USFWS 2008a). Nest counts for the NGMRU are focused on index beaches rather than all beaches where nesting occurs. Analysis of the 12-year dataset (1997-2008) of index nesting beaches in the area shows a statistically significant declining trend of 4.7% annually (NMFS and USFWS 2008a). Nesting on the Florida Panhandle index beaches, which represents the majority of NGMRU nesting, had shown a large increase in 2008, but then declined again in 2009 and 2010 before rising back to a level similar to the 2003-2007 average in 2011. Nesting survey effort has been inconsistent among the GCRU nesting beaches and no trend can be determined for this subpopulation. Zurita et al. (2003) found a statistically significant increase in the number of nests on 7 of the beaches on Quintana Roo, Mexico, from 1987-2001, where survey effort was consistent during the period. However, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS and USFWS 2008a).

In-water Trends

Nesting data are the best current indicator of sea turtle population trends; however, in-water data also provide some insight. Such research suggests the abundance of neritic juvenile loggerheads is steady or increasing. Although Ehrhart et al. (2007) found no significant regression-line trend in a long-term dataset, researchers have observed notable increases in catch per unit effort (CPUE) over the past several years (Ehrhart et al. 2007, Epperly et al. 2007, Arendt et al. 2009). Researchers believe that this increase in CPUE is likely linked to an increase in juvenile abundance, though it is unclear whether this increase in abundance represents a true population increase among juveniles or merely a shift in spatial occurrence. Bjorndal et al. (2005), (cited in NMFS and USFWS (2008a), caution about extrapolating localized in-water trends to the broader population and relating localized trends in neritic sites to population trends at nesting beaches. The apparent overall increase in the abundance of neritic loggerheads in the southeastern United States may be due to increased abundance of the largest oceanic/neritic juveniles (historically referred to as small benthic juveniles), which could indicate a relatively large number of individuals around the same age may mature in the near future (TEWG 2009). However, in-water studies throughout the eastern United States also indicate a substantial decrease in the abundance of the smallest oceanic/neritic juvenile loggerheads, a pattern corroborated by stranding data (TEWG 2009).

Population Estimate

The NMFS Southeast Fishery Science Center developed a preliminary stage/age demographic model to help determine the estimated impacts of mortality reductions on loggerhead sea turtle population dynamics (NMFS-SEFSC 2009a). The model uses the range of published information for the various parameters including mortality by stage, stage duration (years in a stage), and fecundity parameters such as eggs per nest, nests per nesting female, hatchling emergence success, sex ratio, and remigration interval. Resulting trajectories of model runs for each individual recovery unit, as well as the western North Atlantic population as a whole, were found to be very similar. The model run estimates from the 2004-2008 time frame, suggest the adult female population size in the western North Atlantic is approximately 20,000 to 40,000 individuals, with a low likelihood of being up to 70,000 (NMFS-SEFSC 2009a). A less robust estimate for total benthic females in the western North Atlantic was also obtained, yielding approximately 30,000-300,000 individuals, up to less than 1 million (NMFS-SEFSC 2009a).

Threats

The threats faced by loggerhead sea turtles are well-summarized in the general discussion of threats in Section 4.2.1.1. However, the impact of fishery interactions is a point of further emphasis for this species. The Loggerhead Biological Review Team determined that the greatest threats to the NWA DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant et al. 2009). Significant mortality occurs in longline fisheries, bottom and mid-water trawl fisheries, dredge fisheries, gillnet fisheries, and pot/trap fisheries. Although total mortality from all fisheries has not been estimated, the combined mortalities are likely significant.

Regarding the impacts of pollution, loggerheads may be particularly affected by organochlorine contaminants as they were observed in a study by Storelli et al. (2008), to have the highest organochlorine concentrations in sampled tissues (Storelli et al. 2008). Storelli et al. (2008) analyzed tissues from stranded loggerhead sea turtles and found that mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals, and porpoises (Law et al. 1991). It is thought that dietary preferences were likely to be the main differentiating factor leading to different contaminant concentrations among species.

Specific information regarding potential climate change impacts on loggerheads is also available. Future surface temperature increases of 2°–3°C are expected by 2100 (Hansen et al., 2006). Modeling suggests an increase of 2°C in air temperature would result in a sex ratio of over 80% female offspring for loggerheads nesting near Southport, North Carolina from current ratios of 50%-65%. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100% female offspring from current ratios of 90%. Such highly skewed sex ratios could undermine the reproductive capacity of the species. More ominously, an air temperature increase of 3°C is likely to exceed the thermal threshold of most clutches, leading to death (Hawkes et al. 2007). Warmer sea surface temperatures have also been correlated with an earlier onset of loggerhead nesting in the spring (Hawkes et al. 2007; Weishampel et al. 2004), as well as short inter-nesting intervals (Hays et al. 2002) and shorter nesting season (Pike et al. 2006).

4.2.1.3 Green Sea Turtle

The green sea turtle was listed as threatened under the ESA on July 28, 1978, except for the Florida and Pacific coast of Mexico breeding populations, which were listed as endangered.

Species Description and Distribution

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 lb (159 kg) and a straight carapace length of greater than 3.3 ft (1 m). Green sea turtles have a smooth carapace with 4 pairs of lateral (or costal) scutes and a single pair of elongated prefrontal scales between the eyes. They typically have a black dorsal surface and a white ventral surface, although the carapace of green sea turtles in the Atlantic Ocean has been known to change in color from solid black to a variety of shades of grey, green, or brown and black in starburst or irregular patterns (Lagueux 2001).

With the exception of post-hatchlings, green sea turtles live in nearshore tropical and subtropical waters where they generally feed on marine algae and seagrasses. They have specific foraging grounds and may make large migrations between these forage sites and natal beaches for nesting (Hays et al. 2001). Green sea turtles nest on sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands in more than 80 countries worldwide (Hirth and USFWS 1997). The two largest nesting populations are found at Tortuguero, on the Caribbean coast of Costa Rica, and Raine Island, on the Pacific coast of Australia along the Great Barrier Reef. Differences in mitochondrial DNA properties of green sea turtles from different nesting regions indicate there are genetic subpopulations (Bowen et al. 1992; Fitzsimmons et al. 2006). Despite the genetic differences, sea turtles from separate nesting origins are commonly found mixed together on foraging grounds throughout the species' range. However, such mixing occurs at extremely low levels in Hawaiian foraging areas, perhaps making this central Pacific population the most isolated of all green sea turtle populations occurring worldwide (Dutton et al. 2008).

In U.S. Atlantic and Gulf of Mexico waters, green sea turtles are distributed in inshore and nearshore waters from Texas to Massachusetts. Principal benthic foraging areas in the southeastern United States include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984; Hildebrand 1982; Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957; Carr 1984), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon system in Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Guseman and Ehrhart 1992; Wershoven and Wershoven 1992). The summer developmental habitat for green sea turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (Musick and Limpus 1997). Additional important foraging areas in the western Atlantic include the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, scattered areas along Colombia and Brazil (Hirth 1971), and the northwestern coast of the Yucatan Peninsula.

The complete nesting range of green sea turtles within the southeastern United States includes sandy beaches between Texas and North Carolina, as well as the USVI and Puerto Rico (Dow et al. 2007; NMFS and USFWS 1991). However, the vast majority of green sea turtle nesting within the southeastern United States occurs in Florida (Johnson and Ehrhart 1994; Meylan et al. 1995). Principal U.S. nesting areas for green sea turtles are in eastern Florida, predominantly Brevard through Broward counties. For more information on green sea turtle nesting in other ocean basins, refer to the 1991 Recovery Plan for the Atlantic Green Turtle (NMFS and USFWS 1991) or the 2007 Green Sea Turtle 5-Year Status Review (NMFS and USFWS 2007a).

Life History Information
Green sea turtles reproduce sexually, and mating occurs in the waters off nesting beaches. Mature females return to their natal beaches (i.e., the same beaches where they were born) to lay eggs (Balazs 1982; Frazer and Ehrhart 1985) every 2-4 years while males are known to reproduce every year (Balazs 1983). In the southeastern United States, females generally nest

between June and September, and peak nesting occurs in June and July (Witherington and Ehrhart 1989). During the nesting season, females nest at approximately 2-week intervals, laying an average of 3-4 clutches (Johnson and Ehrhart 1996). Clutch size often varies among subpopulations, but mean clutch size is around 110-115 eggs. In Florida, green sea turtle nests contain an average of 136 eggs (Witherington and Ehrhart 1989). Eggs incubate for approximately 2 months before hatching. Survivorship at any particular nesting site is greatly influenced by the level of anthropogenic stressors, with the more pristine and less disturbed nesting sites (e.g., along the Great Barrier Reef in Australia) showing higher survivorship values than nesting sites known to be highly disturbed [e.g., Nicaragua (Campbell and Lagueux 2005; Chaloupka and Limpus 2005)].
After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. This early oceanic phase remains one of the most poorly understood aspects of green sea turtle life history (NMFS and USFWS 2007b). Green sea turtles exhibit particularly slow growth rates of about 1-5 cm per year (Green 1993; McDonald-Dutton and Dutton 1998), which may be attributed to their largely herbivorous, low-net energy diet (Bjorndal 1982). At approximately 20-25 cm carapace length, juveniles leave the pelagic environment and enter nearshore developmental habitats such as protected lagoons and open coastal areas rich in sea grass and marine algae. Growth studies using skeletochronology indicate that green sea turtles in the western Atlantic shift from the oceanic phase to nearshore developmental habitats after approximately 5-6 years (Bresette et al. 2006; Zug and Glor 1998). Within the developmental habitats, juveniles begin the switch to a more herbivorous diet, and by adulthood feed almost exclusively on seagrasses and algae (Rebel and Ingle 1974). However, some populations are known to also feed heavily on invertebrates (Carballo et al. 2002). Green sea turtles reach sexual maturity at 20-50 years of age (Chaloupka and Musick 1997; Hirth and USFWS 1997), which is considered one of the longest ages to maturity of any sea turtle species.

While in coastal habitats, green sea turtles exhibit site fidelity to specific foraging and nesting grounds, and it is clear they are capable of "homing in" on these sites if displaced (McMichael et al. 2003). Reproductive migrations of Florida green sea turtles have been identified through flipper tagging and/or satellite telemetry. Based on these studies, the majority of adult female Florida green sea turtles are believed to reside in nearshore foraging areas throughout the Florida Keys and in the waters southwest of Cape Sable, with some post-nesting turtles also residing in Bahamian waters as well (NMFS and USFWS 2007b).

Status and Population Dynamics
Population estimates for marine turtles do not exist because of the difficulty in sampling turtles over their geographic ranges and within their marine environments. However, researchers have used nesting data to study trends in reproducing sea turtles over time. A summary of nesting trends is provided in the most recent 5-year status review for the species (NMFS and USFWS 2007b) organized by ocean region (i.e., Western Atlantic Ocean, Central Atlantic Ocean, Eastern Atlantic Ocean, Mediterranean Sea, Western Indian Ocean, Northern Indian Ocean, Eastern Indian Ocean, Southeast Asia, Western Pacific Ocean, Central Pacific Ocean, and Eastern Pacific Ocean). Trends at 23 of the 46 nesting beach sites reviewed in the 5-year status review found that nesting at 10 of the sites appeared to be increasing, nesting at 9 appeared to be stable, and

nesting at 4 appeared to be decreasing. With respect to regional trends, the Pacific, the Western Atlantic, and the Central Atlantic regions appeared to show more positive trends (i.e., more nesting sites increasing than decreasing) while the Southeast Asia, Eastern Indian Ocean, and possibly the Mediterranean Sea regions appeared to show more negative trends (i.e., more nesting sites decreasing than increasing). These regional determinations should be viewed with caution since trend data was only available for about half of the total nesting concentration sites examined in the review and site-specific data availability appeared to vary across all regions.

The Western Atlantic region (i.e., the focus of this Opinion) was one of the best performing in terms of abundance in the entire review as there were no sites that appeared to be decreasing. The 5-year status review for the species identified 8 geographic areas considered to be primary sites for green sea turtle nesting in the Atlantic/Caribbean and reviewed the trend in nest count data for each (NMFS and USFWS 2007a). These sites include (1) Yucatán Peninsula, Mexico; (2) Tortuguero, Costa Rica; (3) Aves Island, Venezuela; (4) Galibi Reserve, Suriname; (5) Isla Trindade, Brazil; (6) Ascension Island, United Kingdom; (7) Bioko Island, Equatorial Guinea; and (8) Bijagos Achipelago, Guinea-Bissau. Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precluded a meaningful trend assessment for either (NMFS and USFWS 2007a). Seminoff (2004) likewise reviewed green sea turtle nesting data for 8 sites in the western, eastern, and central Atlantic, including all of the above with the exception that nesting in Florida was reviewed in place of Isla Trindade, Brazil. Seminoff (2004) concluded that all sites in the central and western Atlantic showed increased nesting, with the exception of nesting at Aves Island, Venezuela, where nesting is stable, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic; however, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007a). More information about site-specific trends for the other major ocean regions can be found in the most recent 5-year status review for the species (see NMFS and USFWS (2007a)).

By far, the largest known nesting assemblage in the Western Atlantic region occurs at Tortuguero, Costa Rica. According to monitoring data on nest counts, as well as documented emergences (both nesting and non-nesting events [i.e., false crawls]), there appears to be an increasing trend in this nesting assemblage since monitoring began in the early 1970s. For instance, from 1971-1975 there were approximately 41,250 average annual emergences documented and this number increased to an average of 72,200 emergences from 1992-1996 (Bjorndal et al. 1999). Troëng and Rankin (Troëng and Rankin 2005) collected nest counts from 1999-2003 and also reported increasing trends in the population consistent with the earlier studies, with nest count data suggesting 17,402-37,290 nesting females per year (NMFS and USFWS 2007a). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more resulted in an estimate of the Tortuguero, Costa Rica, population of nesting females growing at 4.9% annually.

In the continental United States, green sea turtle nesting occurs along the Atlantic coast, primarily along the central and southeast coast of Florida where an estimated 200-1,100 females nest each year (Meylan et al. 1994; Weishampel et al. 2003). Occasional nesting has also been documented along the Gulf coast of Florida (Meylan et al. 1995). More recently, green sea turtle nesting has occurred in North Carolina on Bald Head Island, just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. In 2010, a total of 18 nests were found in North Carolina, 6 nests in South Carolina, and 6 nests in Georgia (nesting databases maintained on www.seaturtle.org).

In Florida, FWRI has established index beaches to standardize data collection methods and effort on key nesting beaches. Since establishment of the index beaches in 1989, the pattern of green sea turtle nesting has generally shown biennial peaks in abundance with a positive trend during the ten years of regular monitoring (Figure 7). According to data collected from Florida's index nesting beach surveys from 1989-2012, green sea turtle nest counts across Florida have increased approximately 10-fold from a low of 267 in the early 1990s to a high of 10,701 in 2011. Two consecutive years of nesting declines in 2008 and 2009 caused some concern, but this was followed by increases in both 2010 and 2011 followed by another decrease in 2012 (Figure 7). Modeling by Chaloupka et al. (2008) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%.

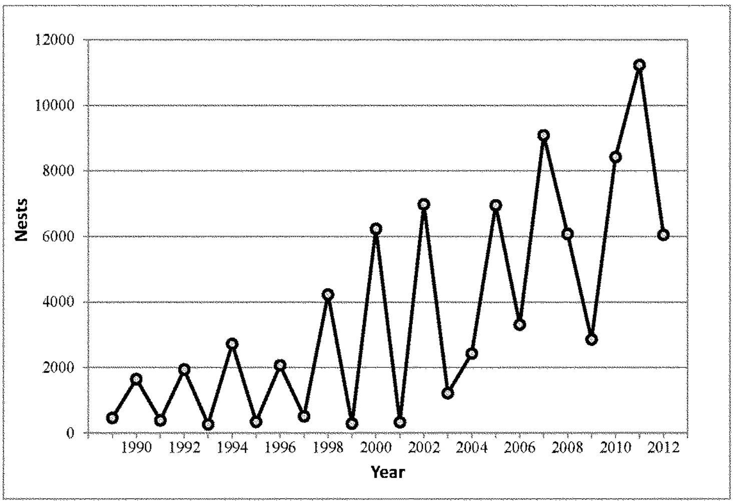

Figure 7. Green sea turtle nesting at Florida index beaches since 1989

Threats

The principal cause of past declines and extirpations of green sea turtle assemblages has been the overexploitation of the species for food and other products. Although intentional take of green sea turtles and their eggs is not extensive within the southeastern United States, green sea turtles that nest and forage in the region may spend large portions of their life history outside the region and outside U.S. jurisdiction, where exploitation is still a threat. Green sea turtles also face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (e.g., plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (e.g., nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. A discussion on general sea turtle threats can be found in Section 4.2.1.1.

In addition to general threats, green sea turtles are susceptible to natural mortality from Fibropapillomatosis (FP) disease. FP results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). These tumors range in size from 0.1 cm to greater than 30 cm in diameter and may affect swimming, vision, feeding, and organ function (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). Presently, scientists are unsure of the exact mechanism causing this disease, though it is believed to be related to both an infectious agent, such as a virus (Herbst et al. 1995), and environmental conditions [e.g., habitat degradation, pollution, low wave energy, and shallow water (Foley et al. 2005)]. Presently, FP is cosmopolitan, but has been found to affect large numbers of animals in specific areas, including Hawaii and Florida (Herbst 1994; Jacobson 1990; Jacobson et al. 1991).

Cold-stunning is another natural threat to green sea turtles. Although it is not considered a major source of mortality in most cases, as temperatures fall below 8°-10°C turtles may lose their ability to swim and dive, often floating to the surface. The rate of cooling that precipitates cold-stunning appears to be the primary threat, rather than the water temperature itself (Milton and Lutz 2003). Sea turtles that overwinter in inshore waters are most susceptible to cold-stunning because temperature changes are most rapid in shallow water (Witherington and Ehrhart 1989). During January 2010, an unusually large cold-stunning event in the southeastern United States resulted in around 4,600 sea turtles, mostly greens, found cold-stunned, with hundreds found dead or dying. A large cold-stunning event occurred in the western Gulf of Mexico in February 2011, resulting in approximately 1,650 green sea turtles being found cold-stunned in Texas. Of these, approximately 620 were found dead or died after stranding, and approximately 1,030 were rehabilitated and released. Additionally, during this same time frame, approximately 340 green sea turtles were found cold-stunned in Mexico, though approximately 300 of those were subsequently rehabilitated and released.

4.2.2 Corals: Staghorn, Mountainous Star, Knobby Star, Lobed Star, Elliptical Star, Lamarck's Sheet, and Rough Cactus

Elkhorn and staghorn corals were listed as threatened under the ESA in May 2006 (71 FR 26852). In December 2012, NMFS proposed changing their status from threatened to endangered (77 FR 73219); a final determination on the status change is still pending. Elkhorn coral does not occur within the project area.

Additionally, in December 2012, NMFS proposed to list 7 coral species (lobed star, mountainous star, knobby star, pillar, rough cactus, Lamarck's sheet, and elliptical star coral) in the western Atlantic, Gulf of Mexico, and/or Caribbean basins under the ESA. Five of those species are proposed as endangered, and 2 species are proposed as threatened (77 FR 73219; December 7, 2012). Pillar coral does not occur within the project area.

General information about corals that pertains to all the listed and proposed coral species is presented at the beginning of each of the subsections. Species-specific information is then presented for each of the listed and proposed coral species. However, lobed star, mountainous star, and knobby star corals are presented as a group since information is often only available for the species complex rather than the individual species.

Species Description
Corals are marine invertebrates in the phylum Cnidaria, which include true stony corals, the blue corals, and fire corals. All of the currently-listed and proposed corals in the NMFS Southeast Region (North Carolina through Texas and the U.S. Caribbean) are stony corals. Stony corals are characterized by polyps with multiples of 6 tentacles around the mouth for feeding and capturing prey items in the water column (Brainard et al. 2011a). Most stony corals form complex colonies made up of a tissue layer of polyps growing on top of a calcium carbonate skeleton, which the polyps produce through the process of calcification.

All of the listed and proposed-for-listing coral species are reef building species, which are capable of rapid calcification rates because of their symbiotic relationship with single-celled dinoflagellate algae, zooxanthellae, which occur in great numbers within the host coral tissues. Zooxanthellae photosynthesize during the daytime, producing an abundant source of energy for the host coral that enables rapid growth. At night, polyps extend their tentacles to filter-feed on microscopic particles in the water column, such as zooplankton, providing additional nutrients for the host coral. In this way, reef-building corals obtain nutrients autotrophically (i.e., via photosynthesis) during the day, and heterotrophically (i.e., via predation) at night (Brainard et al. 2011b).

Staghorn Coral
Staghorn coral (*Acropora cervicornis*; threatened, proposed endangered) coral (*Acropora palmata*; threatened, proposed endangered) are branching species that occur throughout the wider Caribbean. Staghorn corals have straight or slightly curved, cylindrical branches that look like deer antlers. The species range in color from golden yellow to brown, and the growing tips tend to be lighter or lack color. Individual staghorn coral colonies can reach up to 5 ft (1.5 m) across but may form thickets composed of multiple colonies that are difficult to tell apart. Staghorn corals are reef-building species that provide important habitat for other reef organisms, and other reef-building corals cannot fill the unique structural and ecological role of this coral species (Bruckner 2002a).

Lobed Star, Mountainous Star, and Knobby Star Corals
Lobed star coral (*Orbicella annularis*; proposed endangered), mountainous star coral (*Orbicella faveolata*; proposed endangered), and knobby star coral (*Orbicella franksi*; proposed endangered) are the 3 species in the *Orbicella annularis* complex. These 3 species were formerly in the genus *Montastraea*; however, recent work has reclassified the 3 species in the *annularis* complex to the genus *Orbicella* (Budd et al. 2012). The species complex was historically one of the primary reef framework builders throughout the wider Caribbean. The complex was considered a highly plastic, single species – *Montastraea annularis* – with growth forms ranging from columnar, to massive, to platy (formed of plates). In the early 1990s, Weil and Knowlton (1994) suggested the partitioning of these growth forms into separate species, resurrecting the previously described taxa, *Montastraea* (now *Orbicella*) *faveolata* and *Montastraea* (now *Orbicella*) *franksi*. These 3 sibling species were differentiated on the basis of

morphology, depth range, ecology, and behavior (Weil and Knowton 1994). Subsequent reproductive and genetic studies have generally supported the partitioning of the *annularis* complex into three species. *Orbicella faveolata* is the most genetically distinct while *Orbicella annularis* and *Orbicella franksi* are less so (Budd et al. 2012; Fukami et al. 2004; Lopez et al. 1999).

Some studies report on the species complex rather than individual species since visual distinction can be difficult where colony morphology cannot be discerned (e.g. small colonies or photographic methods). Information from these studies is reported for the species complex. Where species-specific information is available, it is reported. However, information about *O. annularis* published prior to 1994 will be attributed to the species complex since it is dated prior to the split of *O. annularis* into 3 separate species.

Lobed star coral colonies grow in columns that exhibit rapid and regular upward growth. Live colony surfaces usually lack ridges or bumps. Colonies can grow to several meters in height and diameter and are commonly grey, green, and brownish in color (Szmant et al. 1997).

Mountainous star corals grow in heads or sheets, the surface of which may be smooth or have keels or bumps. Colonies can reach up to 33 ft (10 m) in diameter with a height of 13-16 ft (4-5 m) and are commonly grey, green, and brownish in color (Szmant et al. 1997).

Knobby star corals are distinguished by large, unevenly arranged polyps that give the colony its characteristic irregular surface. Colony form is variable. Colonies can reach up to 16 ft (5 m) in diameter with a height of up to 6.5 ft (2 m) and are green, grey, and brown in color (Szmant et al. 1997).

Rough Cactus Coral

Rough cactus coral (*Mycetophyllia ferox*; proposed endangered) colonies are encrusting, flat plates. Colonies are thin, weakly attached plates with interconnecting, slightly sinuous, narrow valleys. Colonies are most commonly greys and browns in color with valleys and walls of contrasting colors, and their maximum size is 20 inches (50 cm) in diameter (Veron 2000).

Lamarck's Sheet Coral

Lamarck's sheet coral (*Agaricia lamarcki*; proposed threatened) forms flat or encrusting platy colonies that are commonly arranged in whorls. Colonies are brown in color, usually with pale margins. Polyp mouths are characteristically white and star-shaped. Maximum colony diameter is approximately 3 ft (1 m) (Veron 2000).

Elliptical Star Coral

Elliptical star coral (*Dichocoenia stokesii*; proposed threatened) colonies are either massive and spherical, or form thick, sub-massive plates. Although sometimes green, they are usually orange-brown with white margins between polyps (Veron 2000).

Distribution

In general, the corals in the Southeast Region are widely distributed throughout the western Atlantic, Caribbean, and Gulf of Mexico. Corals need hard substrate on which to settle and form; however, only a narrow range of suitable environmental conditions allows coral to grow and exceed loss from physical, chemical, and biological erosion. Reef-building corals do not thrive outside a narrow temperature range of 25°C-30°C, but they are able to tolerate temperatures outside this range for brief periods of time, depending on how long and severe the exposure to extremes, as well as other biological and environmental factors. Two other important factors influencing suitability of habitat are light and water quality. Reef-building corals require light for photosynthesis of their symbiotic algae, and poor water quality can negatively affect both coral growth and recruitment. Availability of light generally limits how deep corals are found. Hydrodynamic condition (e.g., high wave action) is another important habitat feature, as it influences the growth, mortality, and reproductive rate of each species adapted to a specific hydrodynamic zone.

Staghorn Coral

Staghorn coral commonly grows in water ranging from 15 to 65 ft (5-20 m) in depth and rarely in waters to 196 ft (60 m) (Davis 1982; Jaap 1984; Jaap et al. 1989; Wells 1933). Staghorn coral is widely distributed throughout the western Atlantic and Caribbean. Areas occupied by this coral within U.S. jurisdiction are limited to 4 counties in the state of Florida, Puerto Rico, U.S. Virgin Islands, and Navassa Island. There is currently no evidence of range constriction for this species, though populations throughout the range have decreased substantially since the 1970s.

In Florida, staghorn coral has been documented along the east coast as far north as Palm Beach County. It occurs in deeper water (50-100 ft/16-30 m) at its northernmost range (Goldberg 1973; E. Tichenor, Palm Beach County Reef Rescue, pers. comm. to Jennifer Moore, NMFS 2008) and is distributed across its depth range (15-100 ft/5-30 m) off Broward and Miami-Dade Counties, the Florida Keys, and the Dry Tortugas (Jaap 1984). Off the shore of Broward County, staghorn corals form extensive thickets, which are the largest known remaining populations within U.S. jurisdiction. In Puerto Rico, coral reefs with varying densities of staghorn corals are off all coasts of the main island and around some of its smaller islands. Dense, tall thickets of staghorn coral are present in only a few reefs along the southwest, north, and west shore of the main island and isolated offshore locations (Schärer et al. 2009; Weil et al. 2002). In the U.S. Virgin Islands staghorn corals occur off St. Croix, St. Thomas, and St. John (Brainard et al. 2011a).

Lobed Star, Mountainous Star, and Knobby Star Corals

The 3 species in the *Orbicella annularis* complex (composed of lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and knobby star coral (*Orbicella franksi*) is distributed throughout the Caribbean, Bahamas, and Flower Garden Banks (IUCN 2010; Veron 2000). The complex occurs commonly throughout U.S. waters of the western Atlantic and Caribbean, including Florida (Martin though Monroe counties) and the Gulf of Mexico. The species occupy most reef environments, occurring in both protected and wave exposed habitats (Goreau and Wells 1967; Van Duyl 1985). Lobed star coral occurs shallower than its siblings, in depths ranging from 1.5-66 ft (0.5-20 m) (Szmant et al. 1997). Mountainous and knobby star corals can be found in depths up to 230 ft (70 m [Brainard et al. 2011a]).

Rough Cactus Coral

Rough cactus coral occurs throughout the U.S. waters of the western Atlantic, Caribbean, and Gulf of Mexico (Veron 2000), but has not been reported from Flower Garden Banks (Hickerson et al. 2008). It has also been observed in the Bahamas, but it is absent in the waters of Bermuda. The species occurs in shallow reef environments in depths ranging from 16-98 ft (5 to 30 m [Brainard et al. 2011a]).

Lamarck's Sheet Coral
Lamarck's sheet coral is distributed in the western Atlantic and throughout the Caribbean but is not known to occur in Bermuda (IUCN 2010). In U.S. waters, the species occurs in Florida (Goldberg 1973), Puerto Rico (Acevedo et al. 1989; Garcia-Sais 2010; Morelock et al. 2001), the Virgin Islands (Rogers et al. 1984; Smith et al. 2010), and Flower Garden Banks (Caldow et al. 2009). The species occurs in water depths ranging from 10-249 ft (3-76 m [Carpenter et al. 2008; Ghiold and Smith 1990; Humann 1993]). Although the species can rarely inhabit shaded areas in shallow waters, it primarily occurs at deeper depths. It also inhabits reef slopes and walls and can be one of the most abundant corals on deep reefs (Humann 1993).

Elliptical Star Coral
Elliptical star coral is distributed in the western Atlantic and throughout the Caribbean, the Gulf of Mexico, Florida (including the Florida Middle Grounds), the Bahamas, and Bermuda (Aronson et al. 2008). It is found in most reef environments within its range (Veron 2000), including both back reef and fore reef environments, rocky reefs, lagoons, spur-and-groove formations, channels, and occasionally at the base of reefs (Aronson et al. 2008). The species has been reported in water depths ranging from 6.5-236 ft (2-72 m) (Carpenter et al. 2008).

Life History Information
Corals use a number of diverse reproductive modes (Figure 8). Most coral species reproduce sexually and asexually. Corals reproduce sexually by developing eggs and sperm within the polyps. Some coral species have separate sexes (gonochoric), while others are both sexes at the same time (hermaphroditic). Strategies for fertilization are by "brooding" or "broadcast spawning" (i.e., internal or external fertilization, respectively). Asexual reproduction occurs through fragmentation when pieces of a colony break off and re-attach to hard substrate to form a new colony. Fragmentation results in multiple genetically-identical colonies. In many species of branching corals, fragmentation is a common and sometimes dominant means of propagation.

Depending on the mode of fertilization, coral larvae (called planulae) undergo development either mostly within the mother colony (brooders) or outside in the ocean (broadcast spawners). In either mode of larval development, planula larvae presumably experience considerable mortality (up to 90% or more) from predation or other factors prior to settlement and metamorphosis. Such mortality cannot be directly observed, but is inferred from the large amount of eggs and sperm spawned versus the much smaller number of recruits observed later. Coral larvae are relatively poor swimmers; therefore, their dispersal distances largely depend on how long they remain in the water column and the speed and direction of water currents transporting the larvae. The documented maximum larval life span is 244 days (*Montastraea magnistellata* [Graham et al. 2008]), which suggests that the potential for long-term dispersal of coral larvae, at least for some species, may be substantially greater than previously thought and may partially explain the large geographic ranges of many species.

Biological and physical factors that have been shown to affect spatial and temporal patterns of coral recruitment include:

- substratum availability and community structure (Birkeland 1977)
- grazing pressure (Rogers et al. 1984; Sammarco 1985)
- fecundity, mode, and timing of reproduction (Harriott 1985; Richmond and Hunter 1990)
- behavior of larvae (Goreau et al. 1981; Lewis 1974)
- hurricane disturbance (Hughes and Jackson 1985)
- physical oceanography (Baggett and Bright 1985; Fisk and Harriott 1990)
- the structure of established coral assemblages (Harriott 1985; Lewis 1974)
- chemical cues (Morse et al. 1988)

In general, upon proper stimulation coral larvae settle on appropriate substrates. Some evidence indicates that chemical cues from crustose coralline algae (CCA), microbial films, and/or other reef organisms (Gleason et al. 2009; Morse et al. 1996; Morse et al. 1994; Negri et al. 2001) or acoustic cues from fish and crustaceans in reef environments (Vermeij et al. 2010) stimulate settlement behaviors. Once a settlement site is chosen, the larvae attach to the surface and lay down a calcium carbonate skeleton. Successful recruitment of larvae is the only way new genetic individuals enter a population, thereby maintaining or increasing genotypic diversity (i.e., number of individuals if a population of clonal organisms). The larval stage is also important, as it is the only phase in the life cycle of corals where dispersal occurs over long distances. This helps genetically link populations and provides the potential to re-populate depleted areas. Because newly settled corals barely protrude above the substrate, juveniles need to reach a certain size to limit damage or mortality from threats such as grazing, sediment burial, and algal overgrowth (Bak and Elgershuizen 1976; Birkeland 1977; Sammarco 1985). Once recruits reach about 1-2 years post-settlement, growth and mortality rates appear similar across species. In some species, it appears that there is virtually no limit to colony size beyond structural integrity of the colony skeleton, as polyps apparently can bud indefinitely.

Stony corals require hard substrate for settlement of their larvae, and presence of other benthic organisms (e.g., macroalgae) can preclude settlement. Encrusting sponges and soft corals, zoanthids, and macroalgae are major coral competitors because of their ability to blanket large areas of the sea floor. The presence of macroalgae inhibits coral settlement both by competing for space and by trapping sediment that can abrade and smother small recruits. Juvenile corals are the most susceptible to overgrowth and mortality from these competitors, and corals are generally better able to compete as they grow larger (Bak and Elgershuizen 1976; Birkeland 1977).

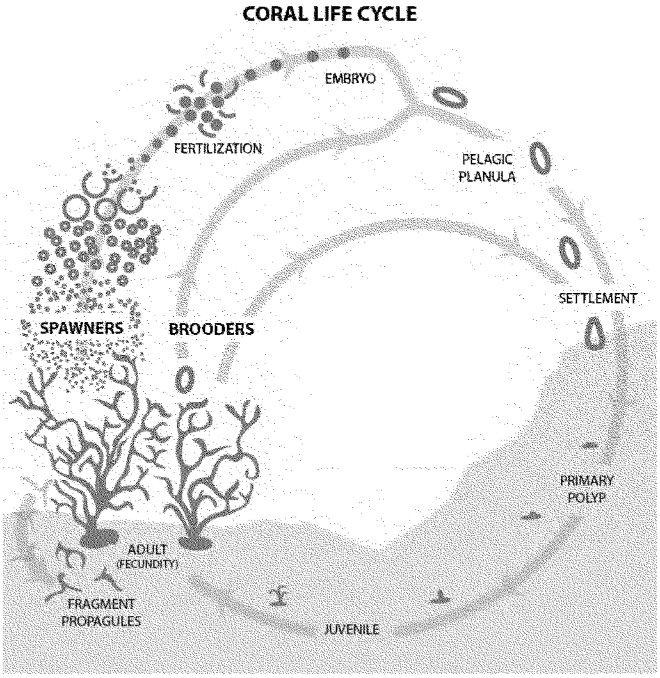

Figure 8. Coral life cycle showing different life history stages for broadcast spawners versus brooders, as well as asexual fragmentation (Reproduced from Brainard et al. 2011. Diagram prepared by Amanda Toperoff, NOAA PIFSC)

Staghorn Coral

Staghorn corals reproduce both sexually and asexually. Staghorn corals are hermaphroditic and are broadcast spawners (Szmant 1986). However, the species cannot self-fertilize, and 2 genetically distinct parents are required to produce viable larvae (Baums et al. 2005). Staghorn corals release gametes a few nights after the full moon during July, August, or September; however, some populations may have spawning events during 2 months. Staghorn colonies reach sexual maturity at 6.5 inches (17 cm) in branch length, but reproductive colonies 3.5 inches (9 cm) in branch length have been observed (Soong and Lang 1992). Skeletal growth rates are fast relative to other Caribbean coral species. Linear extension rates range from 1-4.5 inches (3-11.5 cm) per year for staghorn coral (Becker and Mueller 2001; Gladfelter et al. 1978; Jaap 1974; Shinn 1966; Shinn 1976; Vaughan 1915). New recruits and juveniles typically grow at slower rates. Larger colonies have higher fertility rates and produce proportionally more gametes than small colonies since basal and branch tip tissue are not fertile (Soong and Lang 1992). Fertilized eggs develop into planula larvae over several days in the water column. When larvae are ready to settle, they swim down to the bottom where they crawl along the surface searching for an appropriate settlement site. Certain species of CCA help settlement and post-settlement survival in staghorn coral (Ritson-Williams et al. 2009).

Lobed Star, Mountainous Star, and Knobby Star Corals
All 3 species of the *Orbicella annularis* complex are hermaphroditic broadcast spawners, with spawning concentrated on nights 6-8 following the full moon in late summer (Levitan et al. 2004). Fertilization success measured in the field was generally below 15 % for all 3 species but was highly linked to the number of colonies observed spawning at the same time (Levitan et al. 2004). Minimum size for reproduction of the *O. annularis* species complex was found to be 13 in^2 (83 cm^2) in Puerto Rico and was estimated to correspond to 4-5 years of age (Szmant-Froelich 1985). The *Orbicella annularis* species complex typically exhibits a linear growth of ~0.4 inches (1 cm) per year (Gladfelter et al. 1978), but increased appreciation for the slow rate of growth of post-settlement stages suggest this age for minimum reproductive size may be an underestimate (M.W. Miller, Southeast Fisheries Science Center, Miami, FL. pers. obs., October 2010). Growth rates of the *O. annularis* species complex are also negatively correlated with depth and water clarity (Hubbard and Scaturo 1985). The slow post-settlement growth rates of *O. faveolata* (Szmant and Miller 2005) and small eggs (Szmant et al. 1997) and larvae of all 3 species are factors that may contribute to extremely low post-settlement survivorship, even lower than other Caribbean broadcasters, such as elkhorn coral (Szmant and Miller 2005). Spatial distribution may also affect fecundity on the reef, with deeper colonies of *O. faveolata* being less fecund due to polyp spacing (Villinski 2003).

Successful recruitment by *Orbicella annularis* complex species has seemingly always been rare. (Hughes and Tanner 2000) reported the occurrence of only a single recruit of *Orbicella* over 18 years of intensive observation of 129 ft^2 (12 m^2) of reef in Discovery Bay, Jamaica, while many other recruitment studies throughout the Caribbean also report the species complex to be negligible to absent (Bak and Engel 1979; Rogers et al. 1984). *Orbicella* spp. juveniles also have higher mortality rates than larger colonies (Smith and Aronson 2006). Despite their generally boulder-like form, at least the lobed star coral is capable of some degree of fragmentation/fission and clonal reproduction (Foster et al. 2007).

Rough Cactus Coral
Rough cactus coral is a hermaphroditic brooder and polyps produce 96 eggs per cycle on average (Szmant 1986). It does not reproduce via fragmentation. Their larvae contain zooxanthellae (i.e., symbiotic algae) that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al. 2009). Colony size at first reproduction is greater than 15.5 in^2 (100 cm^2 [Szmant 1986]). Recruitment of this species appears to be very low; even studies from the 1970s reported zero settlement (Dustan 1977).

Lamarck's Sheet Coral
The specific reproductive strategy of Lamarck's sheet coral is presently unknown, but its congeners are primarily gonochoric brooders (i.e., separate sex individuals who partially rear larvae prior to release) (Delvoye 1988; Van Moorsel 1983). The larvae have been reported to primarily settle in relatively deep water (85-121 ft [26-37 m]), although the species has been found in shallow water (Bak and Engel 1979). Larvae of species within the genus are known to use chemical cues from CCA to indicate appropriate settlement substrate (Morse et al. 1988). The species has low recruitment rates. As an example, only one of 1,074 *Agaricia* recruits in a survey at the Flower Garden Banks may have been Lamarck's sheet coral (Shearer and Coffroth 2006). Net sexual recruitment over a decade can be negligible, with reproduction primarily via

fragmentation (Hughes and Jackson 1985). Maximum size for Lamarck's sheet coral is up to ~6.5 ft (2 m) in diameter (Humann 1993), with radial growth rates in Jamaica ranging from 0-0.5 inches (0-1.4 cm) per year, but growing a bit more slowly in depths greater than 65 ft (20 m [Hughes and Jackson 1985]). Rogers et al. (1984) and Bak and Luckhurst (1980) have described the overall life history characteristics of Lamarck's sheet coral as roughly parallel to *Orbicella annularis*, that is, low overall recruitment rates, high survival, and high partial mortality. However, in Jamaica, Lamarck's sheet coral had faster growth, higher recruitment, and lower mortality rates than lobed star coral at the same site and depth (Hughes and Jackson 1985).

Elliptical Star Coral

Reproductive characteristics of elliptical star coral have been described from a histological study of populations in southeast Florida (Hoke 2007). This species is predominantly a gonochoric spawner with an overall sex ratio of 2:1 (male:female), but a small portion of hermaphroditic colonies (~18 %) were also observed in this southeast Florida population. Due to its morphology, elliptical star coral does not reproduce via fragmentation. Minimum colony size at reproduction was 25 in^2 (160 cm^2) in this population, and 2 potential spawning events per year were inferred: one in late August/early September and a second in October. Juvenile density has been reported as very low (Bak and Engel 1979) to relatively common in certain habitats (Chiappone 2010). The annual growth rate has been reported as 0.08-0.3 inches (2-7 mm) per year in diameter and 0.08-0.2 inches (2-5.2 mm) per year in height (Vaughn 1915).

Population Dynamics and Status

Documenting population dynamics for corals is confounded by several unique life history characteristics. Particularly, clonality and asexual reproduction makes it particularly difficult to census a species to determine population abundance estimates. This can only truly be done by tracking genotypically individual colonies within a set area over time to determine if a new colonies in the population are new sexual recruits or colonies formed by asexual reproduction or partial mortality (Williams et al. 2006). This is why coral abundance estimates are usually reported in percent cover rather than number of individuals.

Asexual reproduction can play a major role in maintaining local populations, but in the absence of sexual recruitment, it can also lead to decreased resilience to stressors due to decreased genetic diversity. Since corals cannot move and are dependent upon external fertilization to produce larvae, fertilization success declines greatly as adult density declines. In populations where fragmentation happens often, the number of genetically distinct adults is even lower than colony density. Likewise, when there are fewer adult colonies, there are also fewer sources of fragments to provide for asexual recruitment. These conditions imply that once a population declines to or below a certain level (i.e., the number of adults in an area is too low for sexual reproduction to be effective), the chances for recovery are low. Thus, local (reef-scale) reductions in colony numbers and size may prevent recovery for decades.

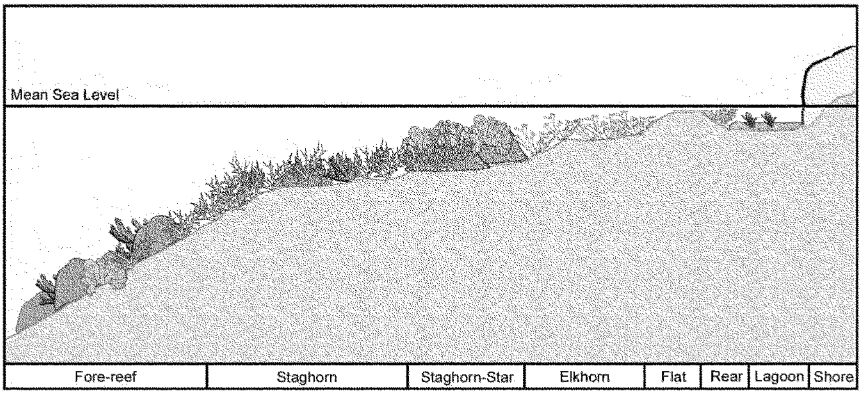

Figure 9. Generalized reef zone schematic (Acropora Biological Review Team 2005)

Staghorn Coral

Historically, staghorn coral was one of the dominant coral species and principle contributors to reef creation in the Atlantic and Caribbean. It commonly formed vast thickets, lending its names to a distinct zone in classical descriptions of Caribbean reef morphology (Figure 9). In the decades of the 1960s and 1970s, many Caribbean reefs were described as having an elkhorn (*A. palmata*) zone based upon high coverage, colony density, and in some cases, near exclusiveness of these species at particular depths (Goreau 1959).

Few historical estimates for staghorn coral population sizes are available because of its historically abundant status, its ability to produce clones through fragmentation, and its tendency to grow together to form complex thickets where individual colonies are difficult to tell apart. Although quantitative data on former distribution and abundance are scarce, in the few locations where quantitative data are available (e.g., Florida Keys, Dry Tortugas, Belize, Jamaica, and the U.S. Virgin Islands), declines in abundance (coverage and colony numbers) are estimated at greater than 97% (*Acropora* Biological Review Team 2005). Staghorn coral underwent precipitous declines throughout its range in the early 1980s due to mortality events associated with white band disease outbreaks and subsequent hurricane damage (Kramer 2002; Rogers et al. 2002). However, there are some small pockets of remnant robust populations such as in southeast Florida (Vargas-Angel et al. 2003), Honduras (Keck et al. 2005; Riegl et al. 2009), and the Dominican Republic (Lirman et al. 2010).

Miller et al. (2013) extrapolated population abundance of staghorn coral in the Florida Keys and Dry Tortugas from stratified random samples across habitat types. Population estimates of staghorn coral in the Florida Keys were 10.2 ± 4.6 (SE) million colonies in 2005, 6.9 ± 2.4 (SE) million colonies in 2007, and 10.0 ± 3.1 (SE) million colonies in 2012. In the Dry Tortugas, population estimates were 0.4 ± 0.4 (SE) million colonies in 2006 and 3.5 ± 2.9 (SE) million colonies in 2008, though the authors note their sampling scheme in the Dry Tortugas was not optimized for staghorn coral. In both the Florida Keys and Dry Tortugas, most of the population was dominated by small colonies less than 30 cm diameter. In the Florida Keys, partial mortality was highest in 2005, with up to 80% mortality observed, and lowest in 2007 with a maximum of 30%. In 2012, partial mortality ranged from 20%-50% across most size classes.

The recent trends in abundance for staghorn coral seem to conform to a pattern of stability punctuated by episodic, catastrophic declines. After the initial declines in the 1980s due to hurricanes and disease, a major El Niño/La Niña Southern Oscillation cycle in 1997-1998 resulted in a large bleaching event and a loss of coral in the Caribbean and the Atlantic (Wilkinson and Souter 2008).

There have been several reports of local trends in abundance. Lidz and Zawada (2013) observed 400 colonies of staghorn coral along 70.2 km of transects near Pulaski Shoal in the Dry Tortugas where the species had not been seen since the cold water die-off of the 1970s, but no thickets were observed. Cover of staghorn coral increased on a Jamaican reef from 0.6% in 1995 to 10.5% in 2004 (Idjadi et al.) and 44% by 2005, but then collapsed after the 2005 bleaching event and subsequent predation to less than 0.5% in 2006 (Quinn and Kojis 2008). Walker et al. (2012b) report increasing size of 2 thickets (expansion of up to 7.5 times the original size of 1 of the thickets) monitored off southeast Florida, but also noted that cover within monitored plots concurrently decreased by about 50%, highlighting the dynamic nature of staghorn coral as it moves around via fragmentation and re-attachment.

Riegl et al. (2009) monitored staghorn coral in photo plots on the fringing reef near Roatan, Honduras from 1996 to 2005. Staghorn coral cover was 0.42% in 1996, declined to 0.14% in 1999 after the Caribbean bleaching event in 1998 and mortality from runoff associated with a Category 5 hurricane, and decreased further to 0.09 % in 2005. Staghorn coral colony frequency decreased 71% between 1997 and 1999. In sharp contrast, offshore banks near Roatan had dense thickets of staghorn coral with 31% cover in photo-quadrats in 2005 and appeared to survive the 1998 bleaching event and hurricane, most likely due to bathymetric separation from land and greater flushing. Modeling showed that under undisturbed conditions, retention of the dense staghorn coral stands on the banks off Roatan is likely with a possible increased shift towards dominance by other coral species. (Riegl et al. 2009).

A report on the status and trends of Caribbean corals over the last century indicates that after the large mortality events of the 1970s and 1980s, cover of staghorn coral has remained relatively stable (though much reduced) throughout the region as has the frequency of reefs at which staghorn coral was described as the dominant coral (IUCN 2013). However, the report also indicates that the number of reefs with staghorn coral present declined during the 1980s, remained relatively stable (though lower) in the 1990s, and then continued to decrease through 2011.

Fragmentation is the most common way of forming new colonies in staghorn corals (Bak and Criens 1982; Davis 1977; Gilmore and Hall 1976; Hughes 1985; Tunnicliffe 1981). However, staghorn coral retains moderate to high levels of genotypic diversity (i.e., the ratio of genetically distinct individuals to all colonies in a population) in many geographic areas (Baums et al. 2010; Baums et al. 2006; Vollmer and Palumbi 2007), though areas with low levels of genotypic diversity also exist. Baums et al. (2010) report staghorn coral at other Florida sites showed higher levels of diversity, indicating a more even reliance on sexual and asexual reproduction.

Studies have found that genetic exchange is restricted between populations separated by greater than 300 miles (500 km), emphasizing the importance of locally diverse populations for the recovery of this species (Baums et al. 2010; Baums et al. 2006; Vollmer and Palumbi 2007).

Settlement of staghorn larvae is rarely detected in coral recruitment studies (Bak and Engel 1979; Rylaarsdam 1983; Sammarco 1980). Studies from across the wider Caribbean, however, confirm 2 overall patterns of sexual recruitment of staghorn corals: (1) low juvenile densities relative to other coral species; and (2) low juvenile densities relative to the commonness of adults (Porter 1987). This pattern suggests that the composition of the adult population is dependent upon variable recruitment and likely reflects the dominance of asexual reproduction by fragmentation for these species (i.e., surviving fragments are usually large and never undergo a "juvenile" stage). Fragmentation can provide a mechanism for locally maintaining and expanding staghorn coral populations. In many locations, populations of staghorn coral have been reduced to such an extent that the potential for recovery through re-growth of fragments is limited. Similarly, as the density of staghorn coral colonies has declined, gametes become diluted, and successful sexual reproduction is less likely and results in reduced potential for exchange of genetic material between populations that are spatially farther apart (Bruckner 2002b). Contributing to density concerns for staghorn coral are observations that spawning does not occur at the same time. Observations at sites in the Florida Keys where distinct genotypes do co-occur in close proximity indicate that they often spawn on different nights preventing effective larval production (Miller et al. unpublished data). Thus, there is evidence to suggest that sexual recruitment of staghorn coral is currently compromised and limiting the potential for recovery.

Lobed Star, Mountainous Star, and Knobby Star Corals
As described above, the 3 species in the *Orbicella annularis* complex were not suggested for formal separation until the mid-1990s and further supported by genetic studies through 2012 (Budd et al. 2012; Fukami et al. 2004; Lopez et al. 1999; Weil and Knowton 1994). In addition, the three species are potentially difficult to tell apart depending on their growth form (e.g., mounding versus platy) and survey method (e.g., video versus in situ). Therefore, many monitoring programs continue to lump the 3 species into the *O. annularis* complex. Future, focused studies may allow for more time to do field identification resulting in high confidence that the reported species is actually the one identified.

The *Orbicella annularis* complex has historically been dominant on Caribbean coral reefs, characterizing the so-called "buttress zone" and "annularis zone" in the classical descriptions of Caribbean reefs (Goreau 1959). There is ample evidence that it has declined dramatically throughout its range, but perhaps at a slower pace than staghorn corals. While the latter began its rapid decline in the early- to mid-1980s, declines in *Orbicella annularis* complex have been much more obvious in the 1990s and 2000s, most often associated with combined disease and bleaching events. In most cases where examined, additional demographic changes accompany these instances of declining abundance (e.g., size structure of colonies, partial mortality).

In Florida, the percent cover data from 4 fixed sites have shown the *Orbicella annularis* complex declined in absolute cover from 5% to 2% in the Lower Keys between 1998 and 2003, and was accompanied by 5% to 40% colony shrinkage and virtually no recruitment (Smith et al. 2008).

Earlier studies from the Florida Keys indicated a 31% decline of *Orbicella annularis* complex absolute cover between 1975 and 1982 at Carysfort Reef (Dustan and Halas 1987) and greater than 75% decline (from over 6% cover to less than 1%) across several sites in Biscayne National Park between the late 1970s and 2000 (Dupont et al. 2008). Further, Ruzicka et al. (2013) documented a Florida Keys-wide decline in all stony coral cover attributable to a decline in the *O. annularis* complex from 1999 to 2009. Most notably, they documented a 25% decline at the deep fore reef sites, where declines are typically not as dramatic. Taken together, these data imply extreme declines in the Florida Keys (80%–95%) between the late 1970s and 2003, and it is clear that further dramatic losses occurred in this region during the cold weather event in January 2010 (Colella et al. 2012).

Similar declines have also been documented for relatively remote Caribbean reefs. At Navassa Island National Wildlife Refuge, percent cover of *Orbicella annularis* complex on randomly sampled patch reefs declined from 26% in 2002 to 3% in 2009, following disease and bleaching events in this uninhabited oceanic island (Miller and Williams 2007). Additionally, 2 offshore islands west of Puerto Rico (Mona and Desecheo) showed reductions in in *O. annularis* complex species (*O. faveolata* and *O. annularis)* live colony counts of 24% and 32% between 1998-2000 and 2008, respectively (Bruckner and Hill 2009). At Desecheo, this demographic decline of one-third of the population corresponded to a decline in *Orbicella annularis* complex cover from over 35% to below 5% across 4 sites.

In the U.S. Virgin Islands, recent data from the U.S. National Park Service's Inventory and Monitoring Program across 6 sites at fixed stations show a decline of *Orbicella annularis* complex from just over 10% cover in 2003 to just over 3% cover in 2009 following mass bleaching and disease impacts in 2005 (Miller et al. 2009). This degree of recent decline was preceded by a decline from over 30% *Orbicella* coverage to approximately 10% between 1988 and 2003, as documented by Edmunds and Elahi (2007). Similarly, percent cover of *Orbicella annularis* complex in a marine protected area in Puerto Rico declined from 49% to 8% between 1997 and 2009 (Hernández-Pacheco et al. 2011). Taken together, these data suggest an 80%-90% decline in *Orbicella annularis* over the past 2 decades in the main U.S. Caribbean territories.

While Bak and Luckhurst (1980) indicated stability in *Orbicella annularis* complex cover across depths in Curaçao during a 5-year study in the mid-1970s, this region has also manifested *Orbicella annularis* complex declines in recent years. Bruckner and Bruckner (2006) documented an 85% increase in the partial mortality of *Orbicella faveolata* and *O. annularis* colonies across 3 reefs in western Curaçao between 1998 and 2005, approximately twice the level for all other stony corals combined. These authors noted that *Orbicella franksi* fared substantially better than the other two complex species in this study. It is likely that *Orbicella annularis* complex populations in Curaçao have fared better than other Caribbean regions, but even those populations are not immune to losses.

Orbicella annularis complex declines in additional locations are noted. For example, at Glovers Reef, Belize, McClanahan and Muthiga (1998) documented a 38%-75% decline in relative cover of *Orbicella annularis* complex across different reef zones between 1975 and 1998, and a further 40% decline in relative cover has occurred since then (Huntington et al. 2011). In contrast, , *O.*

franksi, *O. faveolata*, and *O. annularis* populations have shown stable status at sites in Colombia between 1998 and 2003 (Rodriguez-Ramirez et al. 2010), although demographic changes in *Orbicella annularis* at both degraded and less-degraded reefs imply some degree of population decline in this region (Alvarado-Chacón and Acosta 2009).

Rough Cactus Coral
Rough cactus coral is usually uncommon (Veron 2000) or rare according to published and unpublished records. It constitutes less than 0.1% species contribution (percent of all colonies surveyed) and occurs at densities less than 0.08 colonies per 1 m^2 in Florida (Wagner et al. 2010) and at 0.8 colonies per 100 m transect in Puerto Rico sites sampled by the Atlantic and Gulf Rapid Reef Assessment (Ginsburg and Lang 2003). Recent monitoring data (e.g., since 2000) from Florida (National Park Service permanent monitoring stations), La Parguera, Puerto Rico, and St. Croix (USVI/NOAA Center for Coastal Monitoring and Assessment randomized monitoring stations) show *Mycetophyllia ferox* cover to be consistently less than 1%, with occasional observations up to 2%, and no apparent temporal trend.

Dustan (1977) suggests that *Mycetophyllia ferox* was much more abundant in the upper Florida Keys in the early 1970s than current observations, but that it was highly affected by disease. This data could be interpreted as a substantial decline. Long-term Coral Reef Evaluation and Monitoring Project (CREMP) data in Florida on species presence/absence from fixed stations also show a dramatic decline. For 97 stations in the main Florida Keys, occurrence had declined from 20 stations in 1996 to 4 stations in 2009; in Dry Tortugas occurrence had declined from 8 out of 21 stations in 2004 to 3 stations in 2009 (R. Ruzicka and M. Colella, Florida Marine Research Institute, St. Petersburg, Florida pers. comm. to Jennifer Moore, NMFS, Oct 2010). Recruitment of this species appears to be very low; even studies from the 1970s reported zero settlement (Dustan 1977).

Lamarck's Sheet Coral
Lamarck's sheet coral has been reported to be common (Veron 2000). On reefs at 98-131 ft (30-40 m) depths in the Netherlands Antilles, *Agaricia lamarcki* increased (Bak and Nieuwland 1995) or showed no decline in abundance from 1973 to 1992 (Bak et al. 2005), even though other corals on the same deep reefs decreased. It is not known whether this relative stability at depth holds across the full range of the species. The species has low recruitment rates. As an example, only 1 of 1,074 *Agaricia* recruits in a survey at the Flower Garden Banks may have been *Agaricia lamarcki* (Shearer and Coffroth 2006). Sexual recruitment over a decade has been documented as negligible, with reproduction primarily via fission (Hughes and Jackson 1985). It is a relatively long-lived species (Hughes 1996), with some colonies living more than a century (Hughes and Jackson 1985).

Elliptical Star Coral
Elliptical star coral is usually uncommon (Veron 2000). The overall colony density of *Dichocoenia stokesi* averaged across all habitat types in the south Florida region was ~1.6 colonies per 10 m^2, making it the ninth most abundant coral species in this region (Wagner et al. 2010). Substantial population declines have been reported from a bay in Curaçao (80% decline between 1961 and 1992; Debrot et al. 1998) and the upper Florida Keys (mortality of 75% of colonies across several reef sites after a disease outbreak with no recovery after 7 years;

[Richardson and Voss 2005]). There have been no obvious trends in the abundance of *Dichocoenia stokesi* in monitoring of randomized stations at La Parguera, Puerto Rico or St. John and St. Croix, U.S. Virgin Islands with less than 1.5% cover at most sites. Bak and Engel (1979) reported very low densities of *Dichocoenia* juveniles (approximately 1% of total juvenile colonies). However, reports of juveniles of *Dichocoenia stokesi* have been relatively common compared to most other scleractinian corals in the Florida Keys with mean juvenile densities among 566 sites surveyed during 1999–2009 averaging 0.11 per m^2, but reaching densities as high as one juvenile per m^2 in certain habitats (Chiappone 2010).

Threats

Ocean Warming

Mean seawater temperatures in reef-building coral habitats have increased during the past few decades and are predicted to continue to rise between now and 2100 (IPCC 2013). More importantly, the frequency of warm-season temperature extremes (warming events) in reef-building coral habitat has increased during the past 2 decades and is also predicted to increase between now and 2100 (IPCC 2013). The primary observable coral response to ocean warming is bleaching of coral colonies, wherein corals expel their symbiotic algae (zooxanthellae) in response to stress. Bleaching can affect coral growth, maintenance, reproduction, and survival. An episodic increase of only 1°C-2°C above the normal local seasonal maximum ocean temperature can induce bleaching. Although corals can withstand mild to moderate bleaching, severe, repeated, or prolonged bleaching can lead to colony death and has led to the mass mortality of many coral species during the past 30 years.

In addition to coral bleaching, ocean warming detrimentally affects virtually every life-history stage in reef-building corals. For one Indo-Pacific *Acropora* species, abnormal embryonic development occurs at 32°C, and complete fertilization failure occurs at 34°C (Negri et al. 2007). Further, symbiosis establishment, larval survivorship, and settlement success are impaired in some coral species at temperatures as low as 30°C-32°C (Randall and Szmant 2009; Ross et al. 2013; Schnitzler et al. 2012). Warmer temperatures accelerate the rate of larval development for spawning species, which reduces dispersal distances, the likelihood of successful settlement, and the potential for replenishment of depleted areas (Randall and Szmant 2009).

Multiple threats stress corals simultaneously or sequentially, whether the effects are cumulative, synergistic, or antagonistic. Ocean warming is likely to interact with many other threats, especially considering the long-term consequences of repeated thermal stress, since ocean warming is expected to worsen over this century. Increased seawater temperature interacts with coral diseases to reduce coral health and survivorship. Coral disease outbreaks often have accompanied or immediately followed bleaching events and follow seasonal patterns of high seawater temperatures. The effects of greater ocean warming (i.e., increased bleaching, which kills or weakens colonies) are expected to interact with the effects of higher storm intensity (i.e., increased breakage of dead or weakened colonies) in the Caribbean, resulting in increased rates of coral declines. Likewise, land-based runoff, pollution, or other local stressors may worsen bleaching impacts by increasing coral susceptibility to bleaching and/or increasing the duration of lowered growth after a bleaching event (Carilli et al. 2009; Wooldridge 2009).

Ocean Acidification
Ocean acidification is a result of increased greenhouse gas accumulation, primarily carbon dioxide, in the atmosphere. Ocean acidification is a drop in the pH of seawater that occurs in response to increases in atmospheric carbon dioxide levels that change ocean carbonate chemistry (Caldeira and Wickett 2003). The aragonite saturation state measures the concentration of carbonate ions in the ocean. Corals use carbonate ions to build calcium carbonate skeletons. Thus, decreasing pH and aragonite saturation state are expected to have a major impact on corals and other marine organisms this century by making it more difficult for them to build their skeletons (Fabry 2008). Numerous laboratory and field experiments have shown a relationship between elevated carbon dioxide and decreased calcification rates in particular corals and other calcium carbonate secreting organisms such as CCA (Bates et al. 2009; De Putron et al. 2010; Doney et al. 2009; Langdon et al. 2003). Low-saturation-state water also decreases the rate of biochemical processes that create the cements that infill reefs. A major potential impact from ocean acidification is a reduction in the structural stability of corals and reefs, which results both from increases in bioerosion and decreases in reef cementation. As atmospheric carbon dioxide rises globally, reef-building corals are expected to calcify more slowly and become more fragile.

Laboratory experiments have shown that a declining aragonite saturation state slows the start of and the rate at which newly settled coral larvae create carbonate skeletons (Albright et al. 2008; Cohen et al. 2007; Cohen et al. 2009). Slower growth implies even higher rates of mortality for newly settled corals that are vulnerable to overgrowth competition, sediment smothering, and incidental predation until they reach a refuge at larger colony size. In addition to effects on growth and calcification, recent laboratory experiments have shown that increased carbon dioxide also substantially impairs coral fertilization and settlement success (Albright et al. 2010), suggesting a potential further reduction in recruitment. Community medium-scale studies (Jokiel et al. 2008; Kuffner et al. 2008) showed dramatic declines in the growth rate of CCA and other reef organisms and an increase in the growth of fleshy algae at atmospheric carbon dioxide levels expected later this century. The decrease in CCA growth, coupled with rapid growth of fleshy algae will result in less available habitat for settlement and recruitment of new coral colonies.

Acidification is likely to interact with other threats. Ocean acidification may reduce the temperature threshold at which bleaching occurs (Anthony et al. 2011). Reduced skeletal growth compromises the ability of coral colonies to compete for space against algae, which grows more quickly as nutrient over-enrichment increases. Reduced skeletal density weakens coral skeletons, resulting in greater colony breakage from natural and human-induced physical damage.

Disease
Coral diseases are common and significant threats affecting most coral species. Disease can cause mortality, reduced sexual and asexual reproductive success, and impaired colony growth. A diseased state results from a complex interplay of factors including the cause or agent (e.g., pathogen, environmental toxicant), the host, and the environment. In the case of corals, the host is a complex community of organisms, which includes the coral animal, symbiotic zooxanthellae, and microbial symbionts.

Scientific understanding of individual disease causes in corals remains very poor. Lack of identification of specific pathogens of many coral diseases has hindered the ecological understanding of diseases and the ability to manage them effectively. Several authors have suggested there is a link between increased incidence of coral disease with increased temperature (Bruno et al. 2007; Harvell et al. 1999; Muller et al. 2008; Patterson et al. 2002) that may make corals more prone to infection or make pathogens more potent. An increased prevalence of infectious disease outbreaks has been associated with thermal stress even at temperatures below those required to cause mass bleaching (Bruno et al. 2007). In addition, disease outbreaks have followed bleaching events (Brandt and McManus 2009) and hurricanes (Bruckner and Bruckner 1997; Halley et al. 2001; Miller and Williams 2007; Williams et al. 2008), indicating greater susceptibility to disease when corals are stressed.

Trophic Effects of Fishing
Fishing, particularly overfishing, can have large scale, long-term ecosystem-level effects that can change ecosystem structure from coral-dominated reefs to algal-dominated reefs called a ‘phase shift’ (Hughes 1994). Phase shifts can result when fishing removes species that are particularly important in structuring coral reef ecosystems (Mumby et al. 2007). Effects of fishing can include reducing population abundance of herbivorous fish species that control algal growth, limiting the size structure of fish populations, reducing species richness of herbivorous fish, and releasing corallivores from predator control. If herbivorous fish populations, particularly large-bodied parrotfish, are heavily fished and a major mortality of coral colonies occurs, then algae can grow rapidly and prevent the recovery of the coral population. The ecosystem may then collapse into an alternative stable state– a persistent phase shift in which algae replace corals as the dominant reef species (Mumby et al. 2007). Although algae can have negative effects on adult coral colonies (i.e., overgrowth, bleaching from toxic compounds), the ecosystem-level effects of algae are primarily from inhibited coral recruitment. Filamentous algae can prevent the recruitment of coral larvae by creating sediment traps that obstruct access to a hard substrate for attachment. Additionally, macroalgae reduces coral recruitment through occupation of the available space, shading, abrasion, chemical poisoning, and infection with bacterial disease (Rasher et al. 2012; Rasher and Hay 2010; Rasher et al. 2011).

The trophic effects of fishing are likely to interact with many other threats. For example, when carnivorous fishes are overfished, corallivorous fish populations may increase, resulting in greater predation on corals (Burkepile and Hay 2007). Further, some corallivores are vectors of disease and can transmit disease from one coral colony to another as they transit and consume from each coral colony (Aeby and Santavy 2006). Increasing corallivore abundance results in transmittal of disease to higher proportions of the corals within the population.

Sedimentation
Human activities in coastal watersheds introduce sediment into the ocean by a variety of mechanisms; including river discharge, surface run-off, groundwater seeps, and atmospheric deposition. Elevated sediment levels are generated by poor land use practices and coastal and nearshore construction, including dredging. Nearshore sediment levels will also likely increase with sea level rise due to erosion at the shoreline and re-suspension of lagoonal sediments.

The most common direct effect of sedimentation is deposition of sediment on coral surfaces as it settles out from the water column. Corals with certain morphologies (e.g., mounding) can passively reject settling sediments or corals can actively displace sediment by ciliary action or mucous production, both of which require energetic expenditures (Bak and Elgershuizen 1976; Dallmeyer et al. 1982; Lasker 1980; Stafford-Smith 1993; Stafford-Smith and Ormond 1992). Corals that are unsuccessful in removing sediment will be smothered and die (Golbuu et al. 2003; Riegl and Branch 1995; Rogers 1983). Sediment can also induce sublethal effects, such as reductions in tissue thickness (Flynn et al. 2006) and excess mucus production (Marszalek 1981). In addition, suspended sediment can reduce the amount of light in the water column, making less energy available for coral photosynthesis and growth (Anthony and Hoegh Guldberg 2003; Bak 1978; Rogers 1979). While some corals may be more tolerant of short-term elevated levels of sedimentation, sediment stress and turbidity can induce bleaching (Philipp and Fabricius 2003; Rogers 1979). Finally, sediment impedes fertilization of spawned gametes (Gilmour 2002; Humphrey et al. 2008) and reduces larval settlement, as well as the survival of recruits and juveniles (Birrell et al. 2005; Fabricius et al. 2003).

Sedimentation is also likely to interact with many other threats. For example, when coral communities that are chronically affected by sedimentation experience a warming-induced bleaching event and associated disease outbreaks, the consequences for corals can be much more severe than in communities not affected by sedimentation.

Nutrients
Nutrients (e.g., nitrogen and phosphorous) are added to coral reefs from both point sources (readily identifiable inputs from a single source such as a pipe or drain) and non-point sources (inputs that occur over a wide area and are associated with particular land uses). Anthropogenic sources of nutrients include sewage, agricultural run-off, river and inlet discharges, and groundwater. Development of coastlines and destruction of mangrove forests compound the problem of anthropogenic nutrient runoff, as mangroves are able to filter massive amounts of nutrients and sediment caused by development. Natural processes bring nutrients to coral reefs as well, such as delivery of nutrient-rich deep water by internal waves and upwelling.

Elevated nutrients affect corals through 2 main mechanisms: direct impacts on coral physiology and indirect effects through nutrient-stimulation of other community components (e.g., macroalgae and filter feeders) that compete with corals for space on the reef. Coral reefs are adapted to low nutrient levels, and overabundance of nutrients can cause an imbalance that affects the entire ecosystem. Nutrient-rich water can enhance benthic algae and phytoplankton growth rates in coastal areas, resulting in overgrowth, competition, and algal blooms. Excess nutrient loads affect coral physiology and the balance between corals and their zooxanthellae (Szmant 2002). Increased nutrients can decrease calcification and reduce skeletal density. Either condition results in corals that are more prone to breakage or erosion. Increased levels of nutrients can also compromise coral health (Hodel and Vargas-Angel 2007). Notably, individual species have varying tolerance to increased nutrients.

Nutrients are likely to interact with many other threats. For example, when coral communities that are chronically affected by nutrients experience a warming-induced bleaching event and associated disease outbreaks, the consequences for corals can be much more severe than in communities not affected by nutrients. Additionally, experimental studies on diseased coral species indicate that nutrient augmentation adjacent to active disease lesions substantially increases disease severity (Bruno et al. 2003).

Sea Level Rise

Sea level rise may affect various coral life history events, including larval settlement, polyp development, and juvenile growth. It may also contribute to adult mortality and colony fragmentation, mostly due to increased sedimentation and decreased water quality (reduced light availability) caused by coastal inundation. The best available information suggests that sea level will continue to rise due to thermal expansion and the melting of land and sea ice. Many corals that inhabit the relatively narrow zone near the ocean surface have rapid growth rates when healthy, which allowed them to keep up with sea-level rise during the past periods of rapid climate change associated with de-glaciation and warming. However, depending on the rate and amount of sea level rise, rapid rises can lead to reef drowning. Rapid rises in sea level could affect many coral species by both submerging them below their common depth range and, more likely, by degrading water quality through coastal erosion and potentially severe sedimentation or enlargement of lagoons and shelf areas.

Rising sea level is likely to cause mixed responses in coral species depending on their depth preferences, sedimentation tolerances, and growth rates. Further, the nearshore topography can affect the impact sea level rise has on corals. Reductions in growth rate due to local stressors, bleaching, infectious disease, and ocean acidification may prevent the species from keeping up with sea level rise (e.g., from growing at a rate that will allow them to continue to occupy their preferred depth range despite sea-level rise). Additionally, lack of suitable new habitat, limited success in sexual recruitment, coastal runoff, and transition from natural to constructed shorelines will compound some corals' ability to survive rapid sea level rise.

Predation

Predation on some coral genera, including *Acropora and Orbicella,* is a chronic, though occasionally acute, energy drain (Cole et al. 2008; Rotjan and Lewis 2008). Predators of Caribbean corals include snails, polychaete worms, and several species of fishes. The effects of chronic and frequent predation on corals are usually inconsequential but can become significant once the coral population decreases below a threshold. If the living coral cover is substantially reduced by natural or anthropogenic disturbances, the effects of predation become larger even if the rate of predation does not change. The increased focus of predation on the fewer remaining colonies causes the colony to use energy in defense and could result in a reduced rate of healing and/or fecundity or reduced resistance to stressors and/or disease. Additionally, corallivore populations can also increase due to removal of carnivorous predators (i.e., predators of the corallivores) through fishing. Over-predation can lead to significant coral declines when the rate of coral predation is higher than the rate of healing or coral population replenishment.

Predation is likely to interact with other threats. For instance, predation of coral colonies can increase the likelihood of coral disease infection, and likewise diseased colonies may be more likely to be preyed upon. Additionally, nutrient runoff from land stimulates phytoplankton blooms, which provide food for the larvae of invertebrate corallivores and can cause outbreaks of these predators (Birkeland 1982; Fabricius et al. 2010).

Toxins and Contaminants
Toxins and bioactive contaminants may be delivered to coral reefs via either point or non-point sources. The general effects of contaminants on coral communities are reductions in coral growth, coral cover, and coral species richness (Keller et al. 1991; Loya and Rinkevich 1980; Pait et al. 2007), and a shift in community composition to more tolerant species (Rachello-Dolmen and Cleary 2007). Contaminant effects are species specific and may have harmful effects in combination that would not be evident under experimental exposure to an individual substance.

Laboratory experiments have shown chemical contaminants are harmful to corals. However, linking coral decline to specific contaminants in the environment can be difficult. Low concentrations (parts per billion) of organic chemical contaminants including hydrocarbons (Negri and Heyward 2000), antifoulants (Knutson et al. 2012), pesticides (Negri and Heyward 2001), and metals such as copper, zinc, and iron (Bielmyer et al. 2010; Reichelt-Brushett and Harrison 2000; Reichelt-Brushett and Harrison 2005; Vijayavel et al. 2012) can impact physiological function at various life stages. Estrogen compounds at concentrations that occur in urban or sewage-affected coastal waters (i.e., 2 ng L^{-1}) can affect coral growth and fecundity (Tarrant et al. 2004). In lab experiments, various compounds found in common sunscreens caused coral bleaching (Danovaro et al. 2008). Both oil and chemical dispersants are toxic to coral larvae (Epstein et al. 2000; Negri and Heyward 2000; Goodbody-Gringley et al., unpublished data; K. Ritchie, Mote Marine Lab, pers. comm. to A. Moulding, NMFS, Feb., 2012). While toxic and biologically active substances impair corals, their effects are largely "silent," causing chronic and often sublethal stress or contributing to mortality of unapparent cause.

Physical Impacts
Coral reefs must endure physical damage from many different sources and threats acting over a range of spatial and temporal scales. Extreme wave events, such as those generated by severe tropical hurricanes, are naturally occurring processes that are typically viewed as acute disturbances. Direct physical effects from vessel groundings, anchor damage, and coastal construction activities, such as dredging, mining, and drilling, are somewhat analogous to storm damage in that they are relatively discrete events, although they generally occur over much smaller spatial scales than do storms. Other human-induced disturbances, such as those caused by tourism and recreational events, fishing gear, and marine debris, can have pervasive, chronic physical consequences. Chronic stresses reduce the ability of corals to recover from acute events (Connell et al. 1997). The relationships between injury interval and time required for reef recovery are the primary factors in evaluating equilibrium of the system (Connell 1978).

Staghorn Corals
Staghorn corals displayed severe impacts in the 1998 and 2005 bleaching events, and high temperatures and bleaching have been correlated with coral disease. The shallow reef habitat in which staghorn corals grow is especially vulnerable to increasing air and sea temperatures that accompany global climate change.

Laboratory experiments have shown that acidification reduces skeletal deposition and initiation of calcification in newly settled corals (Albright et al. 2008; Cohen et al. 2007; Cohen et al.

2009). Some CCA species provide chemical cues for settlement and enhanced post-settlement survivorship of *Acropora* larvae (Harrington et al. 2004; Ritson-Williams et al. 2010), suggesting a potential further reduction in recruitment as acidification impacts CCA growth.

White band disease is believed to be the main cause of the initial region-wide decline of staghorn corals (Aronson and Precht 2001), and disease continues to be a major threat to the 2 species. A transmissible disease termed rapid tissue loss affects staghorn coral (Williams and Miller 2005). Additionally, staghorn corals are affected by ciliates (a group of protozoans characterized by the presence of hair-like organelles; [Croquer et al. 2006]). .

Predation is a threat to staghorn corals both through direct removal of tissue and through indirect effects. Known predators include snails (*Coralliophila abbreviata*), fireworms (*Hermodice carunculata*), 2 species of damselfishes (*Stegastes planifrons* and *Microspathodon chrysurus*), and the stoplight parrotfish (*Sparisoma viride*). All of these predators are generalists, feeding on a wide range of coral species, and in some cases algae. Predation effects are more pronounced in areas where staghorn coral abundance or colony sizes are reduced, and predation pressure remains constant.

Staghorn corals appear to be particularly sensitive to sediment deposition and shading effects from increased sediment. Because they are highly dependent upon sunlight for nourishment (Lewis 1977; Porter 1976), staghorn corals are very susceptible to increases in water turbidity. Staghorn corals have poor capacity to remove coarser sediments (250-2000 µm) and only slightly more capacity for removing finer sediments (62-250 µm) (Hubbard and Pocock 1972). Water movement (turbulence) and gravity are probably more important in removing sediments from these species than their capabilities of sloughing sediments in still water (Porter 1987). A sedimentation rate of 200 mg cm^{-2} can cause both lethal (Rogers 1983) and sublethal damage resulting in compromised coral health (Hodel and Vargas-Angel 2007) in this species.

Nutrients impact staghorn corals both directly and indirectly. Nutrients from land-based sources of pollution can cause habitat loss through the stimulation of growth of algae that can occupy space on the reef (Lapointe et al. 2005). Increased levels of nutrients also reduce growth rates in staghorn corals (Renegar and Riegl 2005) and compromise their health (Hodel and Vargas-Angel 2007).

Staghorn corals are sensitive to chemical contaminants. Staghorn coral displayed higher susceptibility to copper toxicity than 2 other coral species tested; effects included depressed photosynthesis, decreased growth, tissue accumulation, and other physiological changes at exposures as low as 4 µg L^{-1} (Bielmyer et al. 2010). Staghorn coral treated with various compounds found in common sunscreens experienced rapid and complete bleaching, even at extremely low concentrations (Danovaro et al. 2008). The response of staghorn coral exposed to drilling muds produced during offshore oil and gas exploration included reduced calcification and reduced tissue soluble protein levels (Kendall et al. 1983).

The branching morphology of staghorn corals makes them particularly vulnerable to physical damage. Major storm events are a natural threat to staghorn corals that result in local population declines (Rogers et al. 1982; Woodley et al. 1981). There are observations from diverse geographical locations of coral disease outbreaks following hurricane disturbances including

Puerto Rico, (Bruckner and Bruckner 1997), Navassa, the Florida Keys, (Miller and Williams 2007; Williams et al. 2008), Bonaire, Curaçao, (*Acropora* Biological Review Team 2005), and Honduras (Halley et al. 2001). Historically, tropical storms likely fostered propagation of staghorn coral thickets through fragmentation, but recent observations from periods of frequent hurricane impacts in the Florida Keys document a lack of successful recruitment of fragments and a severe population decline (Williams et al. 2008). Staghorn corals are less able to successfully reproduce asexually due to high mortality of fragments, and reduced colony density and reef rugosity (Alvarez-Filip et al. 2009) that lessen the likelihood of retaining storm-generated fragments in suitable habitat (Williams et al. 2008). Man-made abrasion and breakage impacts to reefs are chronic and cumulative, and occur on an ongoing basis (e.g., derelict fishing gear, vessel grounding and anchoring, fishing, diver interaction).

Orbicella annularis, Orbicella faveolata, and Orbicella franksi

Because *Orbicella annularis* complex species have traditionally been common and are among the main reef builders in the Caribbean, they have been the frequent subject of research, including responses to and impacts of environmental threats. Published reports of individual bleaching surveys have consistently indicated that *O. faveolata*, *O. annularis*, and the *Orbicella annularis* complex are highly-to-moderately susceptible to bleaching (Brandt 2009; Bruckner and Hill 2009; Oxenford et al. 2008; Wagner et al. 2010). Bleaching can prevent gamete production in *O. annularis* (Mendes and Woodley 2002) and *Orbicella annularis* complex colonies (Szmant and Gassman 1990) in the following reproductive season even after they recover normal pigmentation . Bleaching events leave permanent marks in coral growth records (Leder et al. 1991; Mendes and Woodley 2002). Particularly well-documented mortalities in these species following severe mass-bleaching in 2005 highlight the immense impact that thermal stress events and their aftermath can have on *Orbicella annularis* complex populations (Miller et al. 2009). Using demographic data collected in Puerto Rico over 9 years straddling the 2005 bleaching event, Hernández-Pacheco et al. (2011) showed that population growth rates of *O. annularis* were stable in the pre-bleaching period (2001-2005), but declined in the 2 years following the bleaching event. Simulation modeling of different bleaching probabilities predicted extinction of a population with these dynamics within 100 years at a bleaching probability between 10% and 20%; in other words, once every 5-10 years (Hernández-Pacheco et al. 2011). Cervino et al. (2004) also showed that higher temperatures (over experimental treatments from 20°C-31°C) resulted in faster rates of tissue loss and higher mortality in yellow-band affected *Orbicella annularis* complex. Recent work in the Mesoamerican reef system indicated that *Orbicella faveolata* had reduced thermal tolerances in many locations and over time (Carilli et al. 2010) with increasing human populations, implying increasing local threats (Carilli et al. 2009).

The only study conducted regarding the impact of acidification on this genus is a field study that did not find any change in *Orbicella faveolata* calcification in sampled colonies from the Florida Keys up through 1996 (Helmle et al. 2011). Preliminary experiments testing effects of acidification on fertilization and settlement success of *Orbicella annularis* complex (Albright et al., unpublished data) show results that are consistent with the significant impairments demonstrated for *Acropora palmata* (Albright et al. 2010).

Both Bruckner and Hill (2009) and Miller et al. (2009) demonstrated profound declines for *Orbicella annularis* complex from disease impacts, both with and without prior bleaching. Both white-plague and yellow-band diseases can invoke this type of population level decline. Disease outbreaks can persist for years in a population; *Orbicella annularis* colonies suffering from yellow-band in Puerto Rico in 1999 still manifested similar disease signs 4 years later, with a mean tissue loss of 60% (Bruckner and Bruckner 2006).

Orbicella annularis complex does not suffer from catastrophic outbreaks of predators. While *Orbicella annularis* complex can host large populations of corallivorous snails, they rarely display large feeding scars that are apparent on other coral prey, possibly related to differences in tissue characteristics or nutritional value (Baums et al. 2003). However, low-level predation can have interactive effects with other stressors. For example, predation by butterflyfish can serve as a vector to facilitate infection of *Orbicella faveolata* with black-band disease (Aeby and Santavy 2006). Parrotfishes are also known to preferentially target *Orbicella annularis* , *O. franski,* and *O. faveolata* in so-called "spot-biting," which can leave dramatic signs in some local areas (Bruckner et al. 2000; Rotjan and Lewis 2006). Chronic parrotfish biting can impede colony recovery from bleaching in *O. franksi* and *O. faveolata* (Rotjan et al. 2006). Although it is not predation per se, *Orbicella* colonies have often been infested by other pest organisms. Bio-eroding sponges (Ward and Risk 1977) and territorial damselfishes, *Stegastes planifrons*, can cause tissue loss and skeletal damage. Damselfish infestation of *Orbicella annularis* complex appears to have increased in areas where their preferred, branching coral habitat has declined because of loss of Caribbean acroporids (Precht et al. 2010).

Large, massive, long-lived colonies of *Orbicella annularis* complex lend themselves to retrospective studies of coral growth in different environments, so there is a relatively large amount known or inferred regarding relationships between water quality and *Orbicella annularis* complex growth and status. For example, Tomascik (1990) found an increasing average growth (linear extension) rate of *Orbicella annularis* complex with improving environmental conditions on fringing reefs in Barbados. Within the same study, Tomascik also found a general pattern of decreasing growth rates within the past 30 years at each of the 7 fringing reefs and contributed this decrease to the deterioration of water quality along the west coast of Barbados. Torres and Morelock (2002) noted a similar decline in *Orbicella annularis* complex growth at sediment-impacted reefs in Puerto Rico. Density and calcification rate increased from high to low turbidity and sediment load, while extension rate followed an inverse trend (Carricart-Ganivet and Merino 2001). Eakin et al. (1994) demonstrated declines in *Orbicella annularis* linear extension during periods of construction in Aruba. Downs et al. (2005) suggested that localized toxicant exposure may account for a localized mortality event of *Orbicella annularis* complex in Biscayne National Park. *Orbicella faveolata* had somewhat lesser sensitivity to copper exposure in laboratory assays than *Acropora cervicornis* and *Pocillopora damicornis* (Bielmyer et al. 2010). Nutrient-related runoff has also been deleterious to *Orbicella annularis* complex. Elevated nitrogen reduced respiration and calcification in *Orbicella annularis* and stimulated zooxanthellae populations (Marubini and Davies 1996). Elevated nutrients increased the rate of tissue loss in *Orbicella franksi* and *Orbicella faveolata* affected by yellow-band disease (Bruno et al. 2003). Chronic nutrient elevation can produce bleaching and partial mortality in *Orbicella annularis*, whereas anthropogenic dissolved organic carbon kills corals directly (Kuntz et al. 2005).

Rough Cactus Coral
Rough cactus coral is susceptible to acute and subacute white plague. Dustan (1977) reported dramatic impacts from this disease to the population in the upper Florida Keys in the mid-1970s. He also reported that the rate of disease progression was positively correlated with water temperature and measured rates of disease progression up to 3 mm per day.

The susceptibility of rough cactus corals to nutrients is unknown. However, the absence of this species at fringing reef sites impacted by sewage pollution (Tomascik and Sander 1987) suggests it is highly susceptible to nutrient over-enrichment.

No specific research has addressed the effects of acidification on the genus *Mycetophyllia*

Lamarck's Sheet Coral
Lamarck's sheet coral is susceptible to bleaching at elevated temperatures (Ghiold and Smith 1990), via direct loss of zooxanthellae as well as decreased pigment content (Porter et al. 1989). In laboratory studies in Jamaica, Lamarck's sheet coral tolerated temperatures up to 32°C (Fitt and Warner 1995) but virtually complete disruption of photosynthesis occurred at 32°C–34°C (Warner et al. 1996). Cold stress has also produced bleaching (Bak et al. 2005). Although bleaching can often be extensive, it may not induce mortality in Lamarck's sheet coral (Aronson and Precht 2000; Aronson et al. 1998; Porter et al. 1989).

No specific research has addressed the effects of acidification on the genus *Agaricia*.

Lamarck's sheet coral is vulnerable to white plague disease (Garzon-Ferreira et al. 2001; Nugues 2002; Richardson 1998), ciliate infections (Croquer et al. 2006), and tumors (UNEP 2010). The ecological and population impacts of disease have not been established for *Agaricia lamarcki*.

The effects of land-based sources of pollution (LBSP) on the genus *Agaricia* are largely unknown. *Agaricia* sp. typically have small calices (i.e., skeletal structure in which the coral polyp sits) and are not efficient sediment rejecters (Hubbard and Pocock 1972). *Agaricia lamarcki*'s platy morphology could make it sediment-susceptible. Vertical plates of *Agaricia* shed more sediment than horizontally-oriented ones (Bak and Elgershuizen 1976), and fine sediment suspended in hurricanes can cause much higher mortality in platy corals than hemispherical or non-flat morphologies (Bak, unpublished data; Bak et al. 2005).

Elliptical Star Coral
Although elliptical star coral is susceptible to bleaching, it showed the lowest bleaching response of species observed to bleach in the south Florida region (Wagner et al. 2010). In Barbados elliptical star coral ranked 16th of 21 species in bleaching prevalence during the 2005 Caribbean mass-bleaching event (Oxenford et al. 2008). It was also observed to be bleaching-tolerant in the U.S. Virgin Islands during the same event (Clark et al. 2009). Hence, this species is regarded to be at relatively low threat from temperature-induced bleaching. Elliptical star coral hosts clade B zooxanthellae (Correa et al. 2009; LaJeunesse 2002). Zooxanthellae in clade B do not grow well at high temperatures (Kinzie et al. 2001), but in the field, corals with this clade may be relatively bleaching-resistant (McField 1999). Experimental studies suggest clade B is more bleaching-resistant than clade C, but less resistant than clade A (Warner et al. 2006).

No specific research has addressed the effects of acidification on the genus *Dichocoenia*.

Elliptical star coral is highly susceptible to white plague, with infection increasing with temperature (Borger and Steiner 2005). An outbreak event for this disease in the Florida Keys had demonstrable impact at the local population level, yielding mortality of 75% of colonies across several reef sites, substantial shifts in population structure, and essentially no recovery over a 7-year follow-up period (Richardson and Voss 2005). This species is also susceptible to black-band disease (Sutherland et al. 2004), ciliate infection (Croquer et al. 2006), and dark-spot syndrome (Borger and Steiner 2005). Disease susceptibility appears to be variable (Borger and Steiner 2005); for example, *Dichocoenia stokesi* was minimally affected during a 1998 outbreak in St. Lucia that caused widespread mortality in *Orbicella faveolata* and other species (Nugues 2002).

Elliptical star coral is minimally affected by predation. It can be heavily bioeroded, particularly by bivalves (Highsmith 1981), and lose substantial amounts of tissue to sponge overgrowth (Hill 1998).

One laboratory study (Telesnicki and Goldberg 1995b) has shown that elliptical star coral displays physiological stress at turbidity levels that are within allowable levels as regulated by the State of Florida for coastal construction projects. While light levels and photosynthesis were not affected, respiration levels and mucous production were significantly higher at turbidity levels as low as 14–16 Nephelometric Turbidity Units (NTU), and photosynthesis to respiration ratio fell below 1 at 28–30 NTU (Telesnicki and Goldberg 1995a). An earlier laboratory study examining oil/sediment rejection indicated that elliptical star coral was intermediate (of 19 Caribbean coral species examined) in the rate of sediment removal from its tissues (Bak and Elgershuizen 1976).

4.2.3 Elkhorn and Staghorn Coral Designated Critical Habitat

Elkhorn and staghorn corals require hard, consolidated substrate, including attached, dead coral skeleton, for their larvae to settle. Within the geographical area occupied by a listed species, critical habitat consists of specific areas on which those physical or biological features essential to the conservation of the species are found. For elkhorn and staghorn coral, the physical feature of critical habitat essential to the conservation of the species is substrate of suitable quality and availability, in water depths from the mean high water line to 30 m, to support successful larval settlement, recruitment, and reattachment of fragments. Substrate of suitable quality and availability means consolidated hardbottom or dead coral skeletons free from fleshy and turf macroalgae, and sediment cover. A shift in benthic community structure from coral-dominated to algae-dominated that has been documented since the 1980s means that the settlement of larvae or attachment of fragments is often unsuccessful (Hughes and Connell 1999). Sediment accumulation on suitable substrate also impedes sexual and asexual reproductive success by preempting available substrate and smothering coral recruits.

While algae, including crustose coralline algae and fleshy macroalgae, are natural components of healthy reef ecosystems, increases in the dominance of algae since the 1980s impedes coral recruitment. The overexploitation of grazers through fishing has also enabled fleshy macroalgae to persist in reef and hardbottom areas formerly dominated by corals. Impacts to water quality, in particular nutrient inputs, associated with coastal development are also thought to enhance the growth of fleshy macroalgae by providing them with nutrient sources. Fleshy macroalgae are able to colonize dead coral skeleton and other hard substrate and some are able to overgrow living corals and crustose coralline algae. Because crustose coralline algae is thought to provide chemical cues to coral larvae indicating an area is appropriate for settlement, overgrowth by macroalgae may affect coral recruitment (Steneck 1986). Several studies show that coral recruitment tends to be greater when algal biomass is low (Rogers et al. 1984, Hughes 1985, Connell et al. 1997, Edmunds et al. 2004, Birrell et al. 2005, Vermeij 2006). In addition to preempting space for coral larval settlement, many fleshy macroalgae produce secondary metabolites with generalized toxicity, which also may inhibit settlement of coral larvae (Kuffner and Paul 2004). The rate of sediment input from natural and anthropogenic sources can affect reef distribution, structure, growth, and recruitment. Sediments can accumulate on dead and living corals and exposed hardbottom, thus reducing the available substrate for larval settlement and fragment attachment.

In addition to the amount of sedimentation, the source of sediments can affect coral growth. In a study of 3 sites in Puerto Rico, Torres (2001) found that low-density coral skeleton growth was correlated with increased resuspended sediment rates and greater percentage composition of terrigenous sediment. In sites with higher carbonate percentages and corresponding low percentages of terrigenous sediments, growth rates were higher. This suggests that re-suspension of sediments and sediment production within the reef environment does not necessarily have a negative impact on coral growth while sediments from terrestrial sources increase the probability that coral growth will decrease, possibly because terrigenous sediments do not contain minerals that corals need to grow (Torres 2001).

Long-term monitoring of sites in the U.S.V.I. indicate that coral cover has declined dramatically; coral diseases have become more numerous and prevalent; macroalgal cover has increased; fish of some species are smaller, less numerous, or rare; long-spined black sea urchins are not abundant; and sedimentation rates in nearshore waters have increased from one to 2 orders of magnitude over the past 15 to 25 years (Rogers et al. 2008). Thus, changes that have affected elkhorn and staghorn coral and led to significant decreases in the numbers and cover of these species have also affected the suitability and availability of habitat.

Figure 10, below, shows the boundaries of the Florida area of *Acropora* critical habitat. The Florida area contains 3 sub-areas. The shoreward boundary for Florida sub-area A begins at the 6-ft (1.8 m) contour at the south side of Boynton Inlet, Palm Beach County at 26° 32′ 42.5″ N; then runs due east to the point of intersection with the 98-ft (30 m) contour; then follows the 98-ft (30 m) contour to the point of intersection with latitude 25° 45′ 55″ N, Government Cut, Miami-Dade County; then runs due west to the point of intersection with the 6-ft (1.8 m) contour, then follows the 6-ft (1.8 m) contour to the beginning point. The shoreward boundary of Florida sub-area B begins at the MLW line at 25° 45′ 55″ N, Government Cut, Miami-Dade County; then runs due east to the point of intersection with the 98-ft (30 m) contour; then follows the 98-ft (30 m) contour to the point of intersection with longitude 82°W; then runs due north to the point of intersection with the South Atlantic Fishery Management Council (SAFMC) boundary at 24° 31′ 35.75″ N; then follows the SAFMC boundary to a point of intersection with the MLW line at Key West, Monroe County; then follows the MLW line, the SAFMC boundary (see 50 CFR 600.105(c)), and the COLREGS line (see 33 CFR 80.727. 730, 735, and 740) to the beginning point. The seaward boundary of Florida sub-area C (the Dry Tortugas) begins at the northern intersection of the 98-ft (30 m) contour and longitude 82° 45' W; then follows the 98–ft (30 m) contour west around the Dry Tortugas, to the southern point of intersection with longitude 82° 45' W; then runs due north to the beginning point.

Critical habitat does not include the following particular areas: (1) all areas subject to the 2008 Naval Air Station Key West Integrated Natural Resources Management Plan, (2) all areas containing existing (already constructed) federally authorized or permitted man-made structures such as aids-to-navigation (ATONs), artificial reefs, boat ramps, docks, pilings, maintained channels, or marinas, (3) all waters identified as existing (already constructed) federally authorized channels, and (4) all waters of the Restricted Anchorage Area as described at 33 CFR 334.580, beginning at a point located at 26° 05′ 30'' N, 80 03′ 30'' W.; proceed west to 26° 05′ 30″ N, 80° 06′ 30″ W; thence, southerly to 26° 03′ 00″ N, longitude 80° 06′ 42″ W; thence, east to latitude 26° 03′ 00″ N, 80° 05′ 44″ W.; thence, south to 26° 01′ 36″ N, 80° 05′ 44″ W.; thence, east to 26° 01′ 36″ N, 80° 03′ 30″ W; thence, north to the point of beginning.

The proposed project takes place in sub-area B within the Florida area of critical habitat. The entire Florida area is comprised of 1,329 square miles of designated critical habitat.

Threats

The final critical habitat rule for elkhorn and staghorn coral identifies several sources of threat to the essential feature. Suitable habitat available for larval settlement and recruitment, and asexual fragment reattachment and recruitment of these coral species is particularly susceptible to impacts from human activity because of the shallow water depth range (less than 98 ft/30 m) in which elkhorn and staghorn corals commonly grow and the essential feature occurs. The proximity of this habitat to coastal areas subject this feature to impacts from multiple activities, including, but not limited to dredging and disposal activities, stormwater run-off, coastal and maritime construction, land development, wastewater and sewage outflow discharges, point and non-point source pollutant discharges, fishing, placement of large vessel anchorages, and installation of submerged pipelines or cables. The impacts from these activities, combined with those from natural factors (e.g., major storm events), significantly affect the quality and quantity of available substrate for these threatened species to successfully sexually and asexually reproduce.

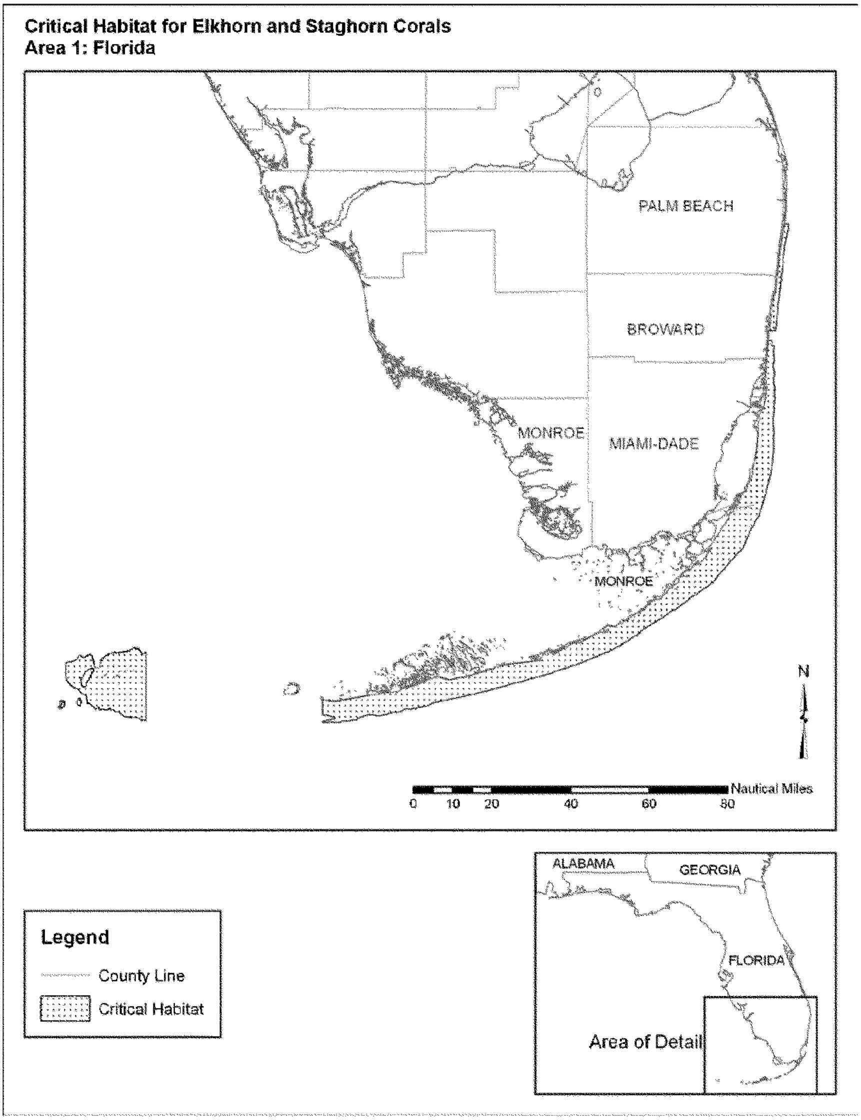

Figure 10. Florida unit designated critical habitat for *Acropora cervicornis* and *Acropora palmata* (50 CFR Parts 223 and 226 Endangered and Threatened Species; Critical Habitat for Threatened Elkhorn and Staghorn Corals; Final Rule)

4.2.4 Johnson's Seagrass

Johnson's seagrass is the first marine plant ever listed under the ESA. It was listed as "threatened" on September 14, 1998, based on the results of fieldwork and a status review initiated in 1990. Kenworthy (1993, 1997, 1999) and NMFS (2007) discuss the field study results and summarize an extensive literature review on the status of Johnson's seagrass. In addition to the published literature, the Johnson's Seagrass Recovery Implementation Team (Recovery Team) is currently updating the 2002 Recovery Plan for Johnson's Seagrass. The updated Recovery Plan is in review, but much of the information contained in this opinion that updates our knowledge of the status of and threats to the species, life history information, and cumulative impacts, comes from talks with Dr. W. Judson Kenworthy (Team Leader) and other NMFS members of the Recovery Team, and from their review of sections of the updated Recovery Plan. That information is attributed throughout this opinion to the Recovery Team. The following discussion summarizes those findings relevant to our evaluation of the proposed action.

Life History and Population Biology
Based on the current knowledge of the species, Johnson's seagrass reproduction is believed to be entirely asexual, and dispersal is by vegetative fragmentation. Sexual reproduction in Johnson's seagrass has not been documented. Female flowers have been found, although dedicated surveys in the Indian River Lagoon have not discovered male flowers, fertilized ovaries, fruits, or seeds either in the field or under laboratory conditions (Jewett-Smith et al. 1997, Hammerstrom and Kenworthy 2002, NMFS 2007). Searches throughout the range of Johnson's seagrass have produced the same results, suggesting either that the species does not reproduce sexually or that the male flowers are difficult to observe or describe, as noted for other *Halophila* species (Kenworthy 1997). Surveys to date indicate that the incidence of female flowers appears to be much higher near the inlets leading to the Atlantic Ocean.

Throughout its range, Johnson's seagrass occurs in dynamic and disjunctive patches. It spreads rapidly, growing horizontally from dense apical meristems with leaf pairs having short life spans (Kenworthy 1997). Kenworthy suggested that the observed horizontal spreading, rapid growth patterns, and high biomass turnover could explain the dynamic patches observed in distribution studies of this species. While patches may colonize quickly, they may also disappear rapidly. Sometimes they will disappear for several years and then re-establish, a process referred to as "pulsating patches" (Heidelbaugh et al. 2000, Virnstein and Morris 2007, Virnstein et al. 2009). Mortality, or the disappearance of patches, can be caused by a number of processes, including burial from bioturbation and sediment deposition (Heidelbaugh et al. 2000), erosion, herbivory, desiccation, and turbidity. In the absence of sexual reproduction, one possible explanation for the pulsating patches is dispersal and reestablishment of vegetative fragments, a process that commonly occurs in aquatic plants and has been demonstrated in other seagrasses (Philbrick and Les 1996, DiCarlo et al. 2005), and was also recently confirmed by experimental mesocosm studies with Johnson's seagrass (Hall et al. 2006).

Johnson's seagrass is a shallow-rooted species and vulnerable to uprooting by wind, waves, storm events, tidal currents, bioturbation, and motor vessels. It is also vulnerable to burial by sand movement and siltation (Heidelbaugh et al. 2000). Having a canopy of only 2-5 cm, it may be easily covered by sediments transported during storms or redistributed by macrofaunal bioturbation during the feeding activities of benthic organisms. Mesocosm experiments indicate that clonal fragments can only survive burial for up to a period of 12 days (W.J. Kenworthy, CCFHR, NOAA, Beaufort, North Carolina, unpublished). Mechanisms capable of disturbing patches may create clonal fragments that become dispersed. Hall et al. (2006) showed that drifting fragments of Johnson's seagrass can remain viable for 4 to 8 days, during which time they can settle, root, and grow. The process of asexual fragmentation can occur year-round. Fragments could drift several kilometers under the influence of wind and tidally- driven circulation, providing potential recruits for dispersal and new patch formation. In the absence of sexual reproduction, these are likely to be the most common forms of dispersal and patch maintenance.

Population Status and Distribution
Johnson's seagrass occurs in a variety of habitat types, including on intertidal wave-washed sandy shoals, on flood deltas near inlets, in deep water, in soft mud, and near the mouths of canals and rivers, where presumably water quality is sometimes poor and where salinity fluctuates widely. It is an opportunistic plant that occurs in a patchy, disjunctive distribution from the intertidal zone to depths of approximately 2-3 meters in a wide range of sediment types, salinities, and in variable water quality conditions (NMFS 2007).

Johnson's seagrass exhibits a narrow geographical range of distribution and has only been found growing along approximately 200 kilometers (km) of coastline in southeastern Florida north of Sebastian Inlet, Indian River County, south to Virginia Key in northern Biscayne Bay, Miami-Dade County. This apparent endemism suggests that Johnson's seagrass has the most limited geographic distribution of any seagrass in the world. Kenworthy (1997, 1999) confirmed its limited geographic distribution in patchy and vertically disjunctive areas throughout its range. Since the last status review (NMFS 2007), there have not been any reported reductions in the geographic range of the species. In fact, the St. Johns River Water Management District (SJRWMD) observed Johnson's seagrass approximately 21 km north of the Sebastian Inlet mouth on the western shore of the Indian River Lagoon – a discovery that slightly extends the species' known northern range (Virnstein and Hall 2009).

Two survey programs regularly monitor the presence and abundance of Johnson's seagrass within this range. One program, conducted by the SJRWMD since 1994, covers the northern section of the species' geographic range between Sebastian Inlet and Jupiter Inlet (Virnstein and Morris 2007, Virnstein et al. 2009). The second recently initiated survey (2006) is of the southern range of the species between Jupiter Inlet and Virginia Key in Biscayne Bay (Kunzelman 2007). Johnson's seagrass is a perennial species (meaning it lasts for greater than 2 growing seasons), showing no consistent seasonal or year-to-year pattern based on the northern transect surveys, but has exhibited some winter decline (NMFS 2007). However, during exceptionally mild winters, Johnson's seagrass can maintain or even increase in abundance from summer to winter. In the surveys conducted between 1994 and 2007, it occurred in 7.1% of the 1-m^2 quadrats in the northern range. Depth of occurrence within these surveys ranged from 0.03 to 2.5 m. Where it does occur, its distribution is patchy, both spatially and temporally. It frequently disappeared from transects only to reappear several months or several years later (NMFS 2007).

Based on the results of the southern transect sampling, it appears there is a relatively continuous, although patchy, distribution of the species from Jupiter Inlet to Virginia Key (NMFS 2007). The largest reported contiguous patch of Johnson's seagrass in the southern range was observed in Lake Worth Lagoon and was estimated to be 30 acres (Kenworthy 1997). Eiseman and McMillan (1980) documented Johnson's seagrass in the vicinity of Virginia Key (latitude 25.75° N); this location is considered to be the southern limit of the species' range. There have been no reports of this species farther south of the currently known southern distribution. The presence of Johnson's seagrass in northern Biscayne Bay (north of Virginia Key) is well documented. In addition to localized surveys, the presence of Johnson's seagrass has been documented by various field experiences and observations of the area by federal, state, and county entities. Johnson's seagrass has been documented in various USACE and USCG permit applications reviewed by NMFS. Findings from the southern transect sampling (summer 2006 and winter 2007) show little difference in the species' frequency or abundance between the summer and winter sampling period. The lower frequencies of Johnson's seagrass occurred at those sites where larger-bodied seagrasses (e.g., *Thalassia testudinum* [turtle grass] and *Syringodium filiforme* [manatee grass]) were more abundant (NMFS 2007). The southern range transect data support some of the conclusions drawn from previous studies and other surveys. This is a rare species; however, it can be found in relatively high abundance where it does occur. Based on the results of the southern transect sampling, it appears that, although it is disjunctively distributed and patchy, there is some continuity in the southern distribution, at least during periods of relatively good environmental conditions and no significant large-scale disturbances (NMFS 2007).

Information on the species' distribution and results of limited experimental work suggest that Johnson's seagrass has a wider tolerance range for salinity, temperature, and optical water quality conditions than other species such as paddle grass, *Halophila decipiens* (Dawes et al. 1989, Kenworthy and Haunert 1991, Gallegos and Kenworthy 1996, Kenworthy and Fonseca 1996, Durako et al. 2003, Kunzelman et al. 2005, Torquemada et al. 2005). Johnson's seagrass has been observed near the mouths of freshwater discharge canals (Gallegos and Kenworthy 1996), in deeper turbid waters of the interior portion of the Indian River Lagoon (Kenworthy 2000, Virnstein and Morris 2007), and in clear water associated with the high energy environments and flood deltas inside ocean inlets (Kenworthy 1993, 1997; Virnstein et al. 1997; Heidelbaugh et al. 2000; Virnstein and Morris 2007). It can colonize and persist in high- tidal-energy environments and has been observed where tidal velocities approach the threshold of motion for unconsolidated sediments (35-40 cm s^{-1}). The persistent presence of high-density, elevated patches of Johnson's seagrass on flood tidal deltas near inlets suggests that it is capable of sediment stabilization. Intertidal populations of Johnson's seagrass may be completely exposed at low tides, suggesting high tolerance to desiccation and wide temperature tolerance.

In Virnstein's study areas within the Indian River Lagoon, Johnson's seagrass was found associated with other seagrass species or growing alone in the intertidal, and, more commonly, at the deep edge of some transects in water depths down to 180 cm. In areas in which long-term poor water and sediment quality have existed until recently, Johnson's seagrass appears to occur in relatively higher abundance, perhaps due to the inability of the larger species to thrive. Johnson's seagrass appears to be out-competed in seagrass habitats where environmental conditions permit the larger seagrass species to thrive (Virnstein et al. 1997, Kenworthy 1997). When the larger, canopy-forming species are absent, Johnson's seagrass can grow throughout the full seagrass depth range of the Indian River Lagoon (NMFS 2007, Virnstein et al. 2009).

Observations by researchers have suggested that Johnson's seagrass exploits unstable environments or newly-created un-vegetated patches by exhibiting fast-growth and support for all local ramets in order to exploit areas in which it could not otherwise compete. It may quickly recruit to locally uninhabited patches through prolific lateral branching and fast horizontal growth. While these attributes may allow it to compete effectively in periodically disturbed areas, if the distribution of this species becomes limited to stable areas it may eventually be out-competed by more stable-selected plants represented by the larger-bodied seagrasses (Durako et al. 2003). In addition, the physiological attributes of Johnson's seagrass may limit growth (i.e., spreading) over large areas of substrate if the substrate is somehow altered (e.g., dredged to a depth that would preclude future recruitment of Johnson's seagrass); therefore, its ability to recover from widespread habitat loss may be limited. The clonal and reproductive growth characteristics of Johnson's seagrass result in its distribution being patchy, noncontiguous, and temporally fluctuating. These attributes suggest that colonization between broadly disjunctive areas is likely difficult and that the species' risk of extinction may be increased if it is removed from large areas within its range by natural or anthropogenic means.

Threats

The emerging consensus among seagrass experts on the Recovery Team is that the possibility of mortality due to reduced salinity over long periods of time is the most clearly identified threat to the species' long-term persistence. Some studies have shown that Johnson's seagrass has a wide tolerance for salinity. However, short-term experiments have shown reduced photosynthesis and increased mortality at low salinities (<10 psu [practical salinity units=parts per thousand]). Longer duration mesocosm experiments have resulted in 100% mortality of Johnson's seagrass after 10 days at salinities <10 psu (Kahn and Durako 2008). The Recovery Team has recently determined that the most significant threat to the species is the present or threatened destruction, modification or curtailment of its habitat or range through water management practices and stochastic environmental factors which can alter the salinity of its habitat. Given that it is not uncommon for salinities to decline below 15-20 psu in its range (Steward et al. 2006), and that a number of natural and human-related factors can affect salinity throughout its range, the Recovery Team identified reduced salinity as a potentially significant threat to the species because the potential for long-term mortality over a large scale could counteract the life history strategy the species uses to persist in the face of numerous, ongoing environmental impacts. In previous reviews, including the critical habitat listing rule and the 2002 Recovery Plan, several additional factors were considered threats, including: (1) dredging and filling, (2) construction and shading from in- and over-water structures, (3) propeller scarring and anchor mooring, (4) trampling, (5) storms, and (6) siltation. In reviewing all information available since the original listing, the Recovery Team conducted assessments of each of these factors and has been unable to confirm that any of these poses a significant threat to the persistence and recovery of the species. A brief discussion of these factors follows.

Routine maintenance dredging associated with the constant movement of sediments in and around inlets may affect seagrasses by direct removal, light limitation due to turbidity, and burial from sedimentation. The disturbance of sediments can also destabilize the benthic community. Altering benthic topography or burying the plants may remove them from the photic zone. Permitted dredging of channels, basins, and other in- and on-water construction projects cause loss of Johnson's seagrass and its habitat through direct removal of the plants, fragmentation of habitat, shading, turbidity, and sedimentation. Although dredge and fill activities can and do adversely affect Johnson's seagrass and its designated critical habitat, federal, state, and local permitting programs closely scrutinize these activities and the construction of in- and over-water structures. The USACE, under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act, has federal authority over the issuance of dredge-and-fill permits. This permitting process includes language to protect and conserve seagrasses through field evaluations, consultations, and recommendations to avoid, minimize, and mitigate for impacts to seagrasses.

Height, width, and orientation have been identified as the 3 most important factors affecting seagrass growth and abundance under and around over-water structures (Burdick and Short 1999, Beal and Schmit 2000). Landry et al. (2008) stated there is a compelling argument supporting prior studies that indicate that docks can have negative impacts on seagrasses by reducing their abundance and in some cases, preventing seagrass from growing. Their study found evidence that all species of seagrass were impacted by docks. However, they found that although it is reduced in frequency under grated docks, Johnson's seagrass was observed in higher densities under the grated docks compared to non-grated docks. Furthermore, their results suggest that Johnson's seagrass does benefit from the light-transmitting characteristics of grated decking. Landry et al. (2008) found that grated docks were more similar to the adjacent and the reference transects (for seagrass) than non-grated docks. This suggests that while both grated and non-grated docks can have detrimental effects on seagrass beds, grated docks are relatively less detrimental to seagrass beds than non-grated docks. Given the supporting experimental evidence that fiberglass grating does improve the incident solar radiation penetrating under structures (Shafer and Robinson 2001), continuing to require grated decking will benefit most seagrasses. Landry et al. (2008) recommend that grated decking should be used for any dock construction to take place over seagrasses, most importantly Johnson's seagrass.

In the results from their study evaluating the regulatory construction guidelines to minimize impacts to seagrasses from single-family residential dock structures in Florida and Puerto Rico, Shafer et al. (2008) emphasized avoidance of seagrasses as a first priority. Avoidance may be achieved by relocating or realigning the structure. It is important to note that Shafer et al. (2008) observed that in the majority of cases, permit applicants and regulatory agencies are, when practicable, generally succeeding in avoiding seagrass impacts by extending the length of the access walkway so that the terminal platform is constructed in deep water that is not conducive to seagrass growth. If avoidance is not possible, Shafer et al. (2008) recommend revising the USACE-NMFS dock construction guidelines to prioritize dock orientation (in a north-south direction) and height (minimum of 5 ft above mean high water) as the most important specifications for the survivorship of seagrasses under docks.

Most dock construction is subject to the construction guidelines (i.e., the USACE and NMFS jointly developed *Key for Construction Conditions for Docks or Other Minor Structures Constructed in or over Johnson's Seagrass* ("Johnsons seagrass key"), dated October 2002 and the associated publication, *Dock Construction Guidelines in Florida for Docks or Other Minor Structures Constructed in or over Submerged Aquatic Vegetation, Marsh, or Mangrove Habitat* ("dock construction guidelines"), dated August 2001. Some docks meeting certain provisions, are exempt from state permitting (http://www.dep.state.fl.us/central/Home/SLERP/Docks/sfdock.pdf) and contribute to loss of Johnson's seagrass through construction impacts and shading.

The USACE's State (Florida) Programmatic General Permit Program (SPGP IV-R1) authorizes permits for in-water construction activities that include: shoreline stabilization projects; construction of boat ramps, boat launch areas and structures associated with such ramps or launch areas; docks, pier associated facilities, and other minor piling-supported structures, and; maintenance dredging of canals and channels. An increasing number of docks in Florida are now permitted through the SPGP. From January 1, 2000-March 31, 2009, the SPGP was utilized 19,927 times of which 52% of this total was for single-family docks. The SPGP does not allow construction in Johnson's seagrass critical habitat. For a dock to be authorized under the SPGP, the applicant must fully comply with the *Johnson's Seagrass Key* and the associated *Dock Construction Guidelines*. Additional project design criteria apply to the SPGP (e.g., docks must be ≤ 1000 sq ft). Similarly, the USACE's SAJ-42 permit allows Miami-Dade County to authorize permits for minor dredging and construction projects within the county. The projects authorized under the SAJ-42 permit must comply with *"Johnson's Seagrass Key"* and the associated *"Dock Construction Guidelines."* No docks were authorized from April 2006 to April 2011 inside of Johnson's seagrass critical habitat outside of Miami-Dade County and only 8 dock/pier projects were authorized in counties within JSG range, but outside of critical habitat (Broward County = 3, Palm Beach County = 3, and 2 in Martin County). Lastly, NMFS recently completed a programmatic consultation on 12 SAJ general permits. The 12 SAJ consultation is for the entire state of Florida, and covered permits issued by the USACE authorize small maintenance dredging, private single-family boat ramps, aerial transmission lines, other minor structures, single-family docks, private multi-family docks, commercial docks, and bulkheads and backfills as long as they meet certain size requirements and limitations on construction methodology.

The Recovery Team has identified weaknesses in the oversight practices of state and federal agencies in the permitting process for some or all of the activities discussed above, due to budget, staffing, and technological limitations. The need for post-construction permit compliance and enforcement for dock structures in Florida and Puerto Rico has been discussed in Shafer et al. (2008). The Recovery Team also identified difficulties in monitoring a rare and patchily-distributed species in single-event surveys associated with permit applications and continues to work with collaborators to improve monitoring methods. The Recovery Team has worked with NMFS's Protected Resources and Habitat Conservation staff to develop and improve guidelines for site monitoring methods (Greening and Holland 2003), dock construction guidelines (NMFS and USACE 2002, Shafer et al. 2008), and best management practices to minimize the impact of docks on Johnson's seagrass (Landry et al. 2008). While it is recognized that dredging and filling and construction and shading from in- and over-water structures can adversely affect Johnson's seagrass and its habitat, the Recovery Team determined that these activities are typically local and small-scale and the deficiencies in the permitting process were not presently a significant threat to the survival of Johnson's seagrass because they will not individually or cumulatively result in long-term, large-scale mortality of Johnson's seagrass, and preclude the species from its strategy of recolonizing areas.

Propeller scarring and improper anchoring are known to adversely affect seagrasses (Sargent et al. 1995, Kenworthy et al. 2002). These activities can severely disrupt the benthic habitat by uprooting plants, severing rhizomes, destabilizing sediments, and significantly reducing the viability of the seagrass community. Propeller dredging and improper anchoring in shallow areas are a major disturbance to even the most robust seagrasses. This destruction is expected to worsen with the predicted increase in boating activity within Florida. The Florida Department of Motor Vehicles reported a total of 1,027,043 registered commercial and recreational vessels statewide in 2007, a peak after years of growth. Registrations declined slightly subsequently, likely due to the economic downturn, to 982,470 in 2009 (DHSMV 2010). This number is likely to increase based on Florida's projected population growth of 18 million in 2006 to 25 million in 2025 (http://www.propertytaxform.state.fl/docs/eo06141.pdf). An increase in the number of registered vessels will likely lead to an increase in adverse effects to seagrasses caused by propeller dredging/scarring. Other indirect effects associated with motor vessels include turbidity from operating in shallow water, dock construction and maintenance, marina expansion, and inlet maintenance dredging. These activities and impacts are also likely to increase (NMFS 2007). Damage to seagrasses from propeller scarring and improper anchoring by motor vessels is recognized as a significant resource management problem in Florida (Sargent et al. 1995). A number of local, state, and federal statutes protect seagrasses from damage due to vessel impacts, and a number of conservation measures, including the designation of vessel control zones, signage, mooring fields, and public awareness campaigns, are directed at minimizing vessel damage to seagrasses. Despite these efforts, vessel damage can have significant local and small-scale (1 m^2 to 100 m^2) impacts on seagrasses (Kirsch et al. 2005), but there is no direct evidence that these small-scale local effects are so widespread that they are a threat to the persistence and recovery of Johnson's seagrass.

Trampling of seagrass beds, a secondary effect of recreational boating, also disturbs seagrass habitat, but is a lesser concern. Trampling damages seagrasses by pushing leaves into the sediment and crushing or breaking the leaves and rhizomes. Since the designation of critical habitat, however, there have been no documented observations or reports of damage by trampling, and if there was, it would be small-scale and local. Therefore, the Recovery Team determined that trampling does not constitute a significant threat to the survival or recovery of Johnson's seagrass.

Large-scale weather events, such as tropical storms and hurricanes, while they often generate runoff conditions that decrease water quality, they also produce conditions (wind setup and abrupt water elevation changes) that can increase flushing rates. The effects of storms can be complex. Specifically documented storm effects on seagrasses include: (1) scouring and erosion of sediments, (2) erosion of seeds and plants by waves, currents, and surge, (3) burial by shifting sand, (4) turbidity, and (5) discharge of freshwater, including inorganic and organic constituents in the effluents (Steward et al. 2006). Storm effects may be chronic, e.g., due to seasonal weather cycles, or acute, such as the effects of strong thunderstorms or tropical cyclones. Studies have demonstrated that healthy, intact seagrass meadows are generally resistant to physical degradation from severe storms, whereas damaged seagrass beds may not be as resilient (Fonseca et al. 2000, Whitfield et al. 2002). In the late summer and early fall of 2004, 4 hurricanes passed directly over the northern range of Johnson's seagrass in the Indian River Lagoon. A post-hurricane random survey in the area of the Indian River Lagoon affected by the 4 hurricanes indicated the presence of Johnson's seagrass was similar to that reported by the SJRWMD transect surveys prior to the storms. This indicates that while the species may temporarily decline, under the right conditions it can return quickly (Virnstein and Morris 2007). Furthermore, despite evidence of longer-term reductions in salinity, increased water turbidity, and increased water color associated with higher than average precipitation in the spring of 2005, there was no evidence of long-term chronic impacts to seagrasses and no direct evidence of damage to Johnson's seagrass that could be considered a threat to the survival of the species (Steward et al. 2006).

Silt derived from adjacent land and shoreline erosion, river and canal discharges, inlets, and internally re-suspended materials can lead to the accumulation of material on plant leaves causing light deprivation. Deposition of silt can also lead to the burial of plants, accumulation of organic matter, and anoxic sediments. Johnson's seagrass grows in a wide range of environments, including those that are exposed to siltation from all the potential sources. Documentation of the direct effects of siltation on seagrasses are generally unavailable. The absence of seagrass has been associated with the formation of muck deposits, however, and localized areas of flocculent, anoxic sediments in isolated basins and segments of the Indian River Lagoon have been observed. Furthermore, sustained siltation experimentally simulated by complete burial for at least 12 days may cause mortality of Johnson's seagrass (W.J. Kenworthy, CCFHR, NOS, Beaufort, North Carolina, unpublished data). In general, the effects of siltation are localized and not widespread and are not likely to threaten the survival of the species.

In addition to the 6 factors discussed above, we also consider the effects of altered water quality on Johnson's seagrass. Availability of light is one of the most significant environmental factors affecting the survival, growth, and distribution of seagrasses (Bulthuis 1983, Dennison 1987, Abal et al. 1994, Kenworthy and Fonseca 1996). Water quality and the penetration of light are affected by turbidity (suspended solids), color, nutrients, and chlorophyll, and are major factors controlling the distribution and abundance of seagrasses (Dennison et al. 1993, Kenworthy and Haunert 1991, Kenworthy and Fonseca 1996). Increases in color and turbidity values throughout the range of Johnson's seagrass are generally caused by high flows of freshwater discharged from water management canals, which can also reduce salinity. Wastewater and stormwater discharges, as well as from land runoff and subterranean sources, are also causes of increased turbidity. Degradation of water quality due to increased land use and poor water management practices continues to threaten the welfare of seagrass communities. Declines in water quality are likely to worsen, unless water management and land use practices can curb or eliminate freshwater discharges and minimize inputs of sediments and nutrients. A nutrient-rich environment caused by inorganic and organic nitrogen and phosphorous loading via urban and agricultural runoff stimulates increased algal growth that may smother or shade Johnson's seagrass, or shade rooted vegetation, and diminish the oxygen content of the water. Low oxygen conditions have a demonstrated negative impact on seagrasses and associated communities.

Based on a Trophic State Index of ambient water quality obtained in the northern and central region of Johnson's seagrass geographic range provided in a long-term monitoring program implemented by the SJRWMD, overall estuarine water quality was assessed as mostly good (67%) (Winkler and Ceric 2006). Only 28% of the stations sampled had fair water quality, while 6% had poor quality. 50% of the sampled estuarine sites were improving, while 6% were degrading, so many more sites were improving than were degrading. Forty-two percent of the lagoon sites had an insignificant trend while 3% had insufficient data to determine a trend. As water management experts have now become confident in the association between water quality and seagrass depth distribution, they have begun establishing water quality targets for the Indian River Lagoon based on seagrass as an indicator (Steward et al. 2005). There is a strong positive correlation between seagrass depth distribution and water quality which enables managers to predict where seagrasses will grow based on water quality and the availability of light. Given that at least half of the sampling stations were indicating long-term improvements in water quality, it can be assumed that seagrass abundance should not be negatively impacted if water and land use management programs continue to be effective. For example, carefully controlling or reducing water flows from discharge canals will moderate salinity fluctuations and reduce turbidity, color, and light attenuation values.

There has not been a comprehensive assessment of water quality published or reported for the southern range of Johnson's seagrass similar to the SJRWMD study. However, the South Florida Water Management District (SFWMD) is working to synthesize water quality information and to gain a more comprehensive understanding of the long-term status and trends of water quality in the southern range of Johnson's seagrass. Of particular concern is an assessment of the impacts of fluctuations in water quality corresponding with variation in climatology, especially "wet years" versus "dry years" variation. Future recovery efforts should include close coordination with the SFWMD and county environmental management agencies in Palm Beach and Dade counties to evaluate the status and trends of water quality in these regions of the species' distribution.

Here, we consider the possible effects of climate change (i.e., rising temperatures and sea levels) on seagrasses in general and on Johnson's seagrass in particular. The earth is projected to warm between 2°-4°C by 2100, and similar projections have been made for marine systems (Sheppard and Rioja-Nieto 2005). At the margins of temperate and tropical bioregions and within tidally-restricted areas where seagrasses are growing at their physiological limits, increased temperatures may result in losses of seagrasses and/or shifts in species composition (Short et al. 2007). The response of seagrasses to increased water temperatures will depend on the thermal tolerance of the different species and their optimum temperature for photosynthesis, respiration, and growth (Short and Neckles 1998). With future climate change and potentially warmer temperatures, there may be a 1-5 m rise in the seawater levels by 2100 when taking into account the thermal expansion of ocean water and melting of glaciers. Rising sea levels may adversely impact seagrass communities due to increases in water depths above present meadows reducing available light. Climate change may also reduce light by shifting weather patterns to cause increased cloudiness. Changing currents may cause erosion and increased turbidity and seawater intrusions higher up on land or into estuaries and rivers, which could increase landward seagrass colonization (Short and Neckles 1998). A landward migration of seagrasses with rising sea levels is a potential benefit, so long as suitable substrate is available for colonization.

It is uncertain how Johnson's seagrass will adapt to rising sea levels and temperatures. Much depends on how much temperatures increase and how quickly. For example, Johnson's seagrass that grows intertidally (e.g., in some parts of the Lake Worth Lagoon) may be affected by a slight change in temperature (since it may already be surviving under less than optimal conditions); however, this may be ameliorated with rising sea levels, assuming Johnson's seagrass would migrate landward with rising sea levels and assuming that suitable substrate would be available for a landward migration. However, rising sea levels could also adversely impact seagrass communities due to increases in water depths above present meadows reducing available light.

Reduction in light availability may benefit some seagrass species (e.g., *Halophila* species that require less light compared to the larger, canopy-forming species); therefore, much depends on the thermal tolerance of the different seagrass species and their optimum temperature for photosynthesis, respiration, and growth (Short and Neckles 1998). While sea level has changed many times during the evolutionary history of Johnson's seagrass, it is uncertain how this species will fare when considering the combined effects of rising temperatures and sea levels (in conjunction with other stressors, such as reduced salinity from freshwater runoff). It has been shown that evolutionary change in a species can occur within a few generations (Rice and Emery 2003), thus making it possible for seagrasses to cope if the changes occur at a rate slow enough to allow for adaptation.

Status Summary
Based on the results of 14 years of monitoring in the species' northern range (1994-2007) and 3 years of monitoring in the species' southern range (2006-2009), there has been no significant change in the northern or southern range limits of Johnson's seagrass (NMFS 2007). It appears that the populations in the northern range are stable and capable of sustaining themselves despite stochastic events related to severe storms (Steward et al. 2006) and fluctuating climatology. Longer-term monitoring data is needed to confirm the stability of the southern distribution of the species (NMFS 2007). Larger seagrasses, predominantly turtle grass (*Thalassia testudinum*), begin to out-compete Johnson's seagrass in this area. While there has been a slight extension in the known northern range (Virnstein and Hall 2009), the limits of the southern range appear to be stable (Latitude 25.75°N in the vicinity of Virginia Key). There have been no reports of this species farther south of the currently known southern distribution.

As discussed in the Threats section, NMFS has determined that the most clearly identified threat to date is the possibility of mortality due to reduced salinity over long periods of time. The other potential threats discussed above (i.e., dredging/filling, construction and shading from in and over-water structures, propeller scarring and anchor mooring, trampling, storms, and siltation) were determined to be generally local and small-scale and are not considered threats to the survival and recovery of the species (NMFS 2007). It is uncertain how Johnson's seagrass and other seagrass species will fare due to the synergistic effects of rising temperatures and sea levels (in combination with other stressors, such as reduced salinity from freshwater runoff). It has been shown that evolutionary change in a species can occur within a few generations (Rice and Emery 2003), thus making it possible for seagrasses to cope if the changes occur at a rate slow enough to allow for adaptation.

5 Environmental Baseline

This section is a description of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area.[8] The environmental baseline is a "snapshot" of a species' health at a specified point in time. It does not include the effects of the action under review in the consultation.

By regulation, environmental baselines for biological opinions include the past and present impacts of all state, federal, or private actions and other human activities in the action area. We identify the anticipated impacts of all proposed federal projects in the specific action area of the consultation at issue, that have already undergone formal or early Section 7 consultation as well as the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Focusing on the impacts of the activities in the action area specifically, allows us to assess the prior experience and state (or condition) of the endangered and threatened individuals, and areas of designated critical habitat that occur in an action area, and that will be exposed to effects from the action under consultation. This is important because, in some phenotypic states or life history stages, listed individuals will commonly exhibit, or be more susceptible to, adverse responses to stressors than they would be in other states, stages, or areas within their distributions. The same is true for localized populations of endangered and threatened species: the consequences of changes in the fitness or performance of individuals on a population's status depends on the prior state of the population. Designated critical habitat is not different: under some ecological conditions, the physical and biotic features of critical habitat will exhibit responses that they would not exhibit in other conditions.

5.1 Sea Turtles

5.1.1 Status of Sea Turtles within the Action Area

Green and loggerhead sea turtles occur in the action area and may be adversely affected by the project. The action area does not include any nesting beach, important foraging habitat (e.g. nearshore hardbottom), or known breeding habitat. Sea turtles found in the immediate project area may travel widely throughout the Atlantic, Gulf of Mexico, and Caribbean Sea, and individuals found in the action area can potentially be affected by activities anywhere within this wide range. These impacts outside of the action area are discussed and incorporated as part of the overall status of the species as detailed in Section 3 above. Sea turtles that occur in the action area are highly migratory, as are all sea turtles species worldwide. For the species that are globally listed, the status of these species in the Atlantic (see Section 4) most accurately reflects the species' status within the action area. In Section 4, we presented available information on sea turtle population abundance and trends by species. The action area does not contain any important developmental habitat (e.g. nearshore hardbottom) and it is not near any nesting beaches.

5.1.2 Factors Affecting Sea Turtles in the Action Area

[8] The action area is defined by regulation as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 CFR 402.02).

NMFS has completed a number of Section 7 consultations to address the effects of federally-permitted fisheries and other federal actions on threatened and endangered sea turtle species, and when appropriate, has authorized the incidental taking of these species. Each of those consultations sought to minimize the adverse impacts of the action on sea turtles. NMFS has undertaken conservation actions under the ESA to address sea turtle takes in the fishing and shipping industries and other activities such as USACE dredging operations. The summary below of federal actions and the effects these actions have had or are having on sea turtles includes only those federal actions in, or with effects within, the action area that have already concluded or are currently undergoing formal Section 7 consultation.

Federal Vessel Activity and Operations
Potential sources of adverse effects from federal vessel operations in the action area include operations of the USN and USCG. NMFS has conducted formal consultations with the USCG and the USN on their vessel operations. Through the Section 7 process, where applicable, NMFS has and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. Refer to the biological opinions for the USCG (NMFS 1995) and the USN (NMFS 1996, 1997a) for details on the scope of vessel operations for these agencies and conservation measures being implemented as standard operating procedures.

Dredging
The construction and maintenance of federal navigation channels and sand mining sites ("borrow areas") conducted by the USACE has been identified as a source of sea turtle mortality. Hopper dredges in the dredging mode are capable of moving relatively quickly, compared to sea turtle swimming speeds and can thus overtake, entrain, and kill sea turtles as the suction draghead of the advancing dredge overtakes the resting or swimming turtle. Entrained sea turtles rarely survive. NMFS completed a regional biological opinion on the impacts of USACE's South Atlantic coast hopper-dredging operations in 1997 for dredging in the USACE's South Atlantic Division (NMFS 1997b). The regional biological opinion on South Atlantic hopper dredging (SARBO) of navigational channels and borrow areas determined that hopper dredging would not adversely affect leatherback sea turtles in the South Atlantic Division (i.e., coastal states of North Carolina through Key West, Florida). The opinion did determine hopper dredging in the South Atlantic Division would adversely affect 4 sea turtle species (i.e., green, hawksbill, Kemp's ridley, and loggerheads) but would not jeopardize their continued existence. An ITS for those species was issued. Reinitiation of consultation on the SARBO has been triggered for a number of reasons, including listing of new species and designation of critical habitat that may be affected by these dredging activities.

ESA Permits
Sea turtles are the focus of research activities authorized by Section 10 permits under the ESA. Regulations developed under the ESA allow for the issuance of permits allowing take of certain ESA-listed species for the purposes of scientific research under Section 10(a)(1)(a) of the ESA. Authorized activities range from photographing, weighing, and tagging sea turtles incidentally taken in fisheries, to blood sampling, tissue sampling (biopsy), and performing laparoscopy on intentionally captured sea turtles. The number of authorized takes varies widely depending on the research and species involved, but may involve the taking of hundreds of sea turtles annually.

Most takes authorized under these permits are expected to be (and are) nonlethal, although lethal takes are sometimes authorized. Before any research permit is issued, the proposal must be reviewed under the permit regulations. In addition, since issuance of the permit is a federal activity, issuance of the permit by NMFS must also be reviewed for compliance with Section 7(a)(2) of the ESA to ensure that issuance of the permit does not result in jeopardy to the species or adverse modification of its critical habitat.

Federally-Managed Fisheries
Threatened and endangered sea turtles are adversely affected by fishing gears used throughout the continental shelf of the action area. Hook-and-line gear, trawl, and pot fisheries have all been documented as interacting with sea turtles.

For all fisheries for which there is a Fishery Management Plan (FMP) or for which any federal action is taken to manage that fishery, impacts have been evaluated under Section 7.

Finfish Fisheries
Adverse effects on threatened and endangered species from several types of fishing gear occur in the action area of the proposed action. Efforts to reduce the adverse effects of commercial fisheries are addressed through the ESA Section 7 process. Trawl, hook-and-line, gillnet, and cast net gear fisheries have all been documented as interacting with sea turtles. Several formal consultations have been conducted on the following fisheries that NMFS has determined are likely to adversely affect threatened and endangered species (including sea turtles): the South Atlantic and Gulf of Mexico coastal migratory pelagic fishery, and the Atlantic Highly Migratory Species shark fishery. An Incidental Take Statement (ITS) has been issued for interactions with sea turtles in each of these fisheries.

NMFS completed a Section 7 consultation on the continued authorization of the coastal migratory pelagic fishery in the South Atlantic (NMFS 2007c) where hook-and-line, gillnet, and cast net gears are used. The recreational sector uses hook-and- line gear. The hook-and-line effort is primarily trolling. The biological opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles may be adversely affected by operation of the fishery.

In 2012, NMFS issued a biological opinion on the continued authorization of Highly Migratory Species Atlantic shark fisheries (NMFS 2012). This commercial fishery uses bottom longline and gillnet gear. The recreational sector of the fishery uses only hook-and-line gear. To protect declining shark stocks, the proposed action seeks to greatly reduce the fishing effort in the commercial component of the fishery. These reductions are likely to greatly reduce the interactions between the commercial component of the fishery and sea turtles. The biological opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles may be adversely affected by operation of the fishery but that the proposed action was not expected to jeopardize the continued existence of any of these species.

Southeastern Shrimp Trawl Fisheries
Southeast U.S. shrimp fisheries target primarily brown, white, and pink shrimp in inland waters and estuaries through the state-regulated territorial seas and in federal waters of the EEZ. As sea turtles rest, forage, or swim on or near the bottom, they are captured by shrimp trawls pulled along the bottom. In 1990, the National Research Council (NRC) concluded that the Southeast shrimp trawl fisheries affected more sea turtles than all other activities combined and was the most significant anthropogenic source of sea turtle mortality in the U.S. waters, in part due to the high reproductive value of turtles taken in this fishery (NRC 1990).

On May 9, 2012, NMFS completed a Biological Opinion that analyzed the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the Magnuson-Stevens Act (NMFS 2012). The Opinion also considered a proposed amendment to the sea turtle conservation regulations that would withdraw the alternative tow time restriction at 50 CFR 223.206(d)(2)(ii)(A)(*3*) for skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) and instead require all of these vessels to use TEDs. The Opinion concluded that the proposed action would not jeopardize the continued existence of any sea turtle species. An ITS was provided that used trawl effort and capture rates as proxies for sea turtle take levels. The Biological Opinion requires NMFS to minimize the impacts of incidental takes through monitoring of shrimp effort and regulatory compliance levels, conducting TED training and outreach, and continuing to research the effects of shrimp trawling on listed species. Consultation for this fishery has recently been reinitiated.

Beach Nourishment
The USACE issues Clean Water Act permits for disposal of material in navigable waters of the United States, including beach nourishment. The activity of beach nourishment, especially when impacts include the loss of nearshore hardbottom habitat along the east coast of Florida, has been documented to result in injury and death of juvenile green sea turtles. Juvenile green turtles are known to utilize these high-energy, dynamic habitats for foraging and as refuge, and show a preference for this habitat even when abundant deeper-water sites are available. The loss of such limited habitat, especially when considering the cumulative loss as a result of beach nourishment activities occurring along the entire range of the habitat and continually over time, is expected to result in loss of foraging opportunities and protective refuge. The stresses are also expected to contribute to mortality of individuals already in poor condition as a result of disease or other factors (NMFS 2008a). Beach nourishment permitted by the USACE also often involves use of a hopper dredge to collect nourishment material, thus posing another route of adverse effects to sea turtles.

State or Private Actions
Maritime Industry
Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with ESA-listed species. The effects of fishing vessels, recreational vessels, or other types of commercial vessels on listed species may involve disturbance or injury/mortality due to collisions or entanglement in anchor lines. Commercial traffic and recreational pursuits can also adversely affect sea turtles through propeller and boat strikes. The Sea Turtle Stranding and Salvage Network (STSSN) includes many records of

vessel interaction (propeller injury) with sea turtles where there are high levels of vessel traffic. The extent of the problem is difficult to assess because of not knowing whether the majority of sea turtles are struck pre- or post-mortem. It is important to note that minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so it is more likely to become vulnerable to effects such as entanglements. NMFS and the USCG have completed several formal consultations on individual marine events that may affect sea turtles.

Coastal Development
Beachfront development, lighting, and beach erosion control all are ongoing activities along the Florida coastline. These activities potentially reduce or degrade sea turtle nesting habitats or interfere with hatchling movement to sea. Nocturnal human activities along nesting beaches may also discourage sea turtles from nesting sites. The extent to which these activities reduce sea turtle nesting and hatchling production is unknown. However, more and more coastal counties are adopting stringent protective measures to protect hatchling sea turtles from the disorienting effects of beach lighting.

State Fisheries
Commercial state fisheries are located in the nearshore habitat areas that comprise the action area. Recreational fishing from private vessels also occurs in the area. Observations of state recreational fisheries have shown that loggerhead sea turtles are known to bite baited hooks and frequently ingest the hooks. Hooked turtles have been reported by the public fishing from boats, piers, and beach, banks, and jetties and from commercial anglers fishing for reef fish and for sharks with both single rigs and bottom longlines (NMFS 2001). Additionally, lost fishing gear such as line cut after snagging on rocks, or discarded hooks and line, can also pose an entanglement threat to sea turtles in the area. A detailed summary of the known impacts of hook-and-line incidental captures to loggerhead sea turtles can be found in the TEWG reports (1998; 2000).

In August of 2007, NMFS issued a regulation (72 FR 43176, August 3, 2007) to require any fishing vessels subject to the jurisdiction of the United States to take observers upon NMFS's request. The purpose of this measure is to learn more about sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle takes, and to determine whether additional measures to address prohibited sea turtle takes may be necessary.

Other Potential Sources of Impacts in the Environmental Baseline
Marine Debris and Acoustic Impacts
A number of activities that may affect listed species in the action area of this consultation include anthropogenic marine debris and acoustic impacts. The impacts from these activities are difficult to measure. Where possible, conservation actions are being implemented to monitor or study impacts from these sources.

Marine Pollution and Environmental Contamination
Sources of pollutants along the coastal areas include atmospheric loading of pollutants such as polychlorinated biphenyls (PCBs), stormwater runoff from coastal towns and cities into rivers and canals emptying into bays and the ocean, and groundwater and other discharges (Carpenter et al, 1986). Nutrient loading from land-based sources such as coastal community discharges is

known to stimulate plankton blooms in closed or semi-closed estuarine systems (Bowen and Valiela, 2001; Rabalais 2002, Rabalais et al 2002). The effects on larger embayments are unknown. Although pathological effects of oil spills have been documented in laboratory studies of marine mammals and sea turtles (Vargo et al. 1986), the impacts of many other anthropogenic toxins have not been investigated.

Coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased under water noise and boat traffic can degrade marine habitats used by sea turtles (Colburn et al. 1996). The development of marinas and docks in inshore waters can negatively impact nearshore habitats. An increase in the number of docks built increases boat and vessel traffic. Fueling facilities at marinas can sometimes discharge oil, gas, and sewage into sensitive estuarine and coastal habitats. Although these contaminant concentrations do not likely affect the more pelagic waters, the species of turtles analyzed in this biological opinion travel between near shore and offshore habitats and may be exposed to and accumulate these contaminants during their life cycles.

There are studies on organic contaminants and trace metal accumulation in green and leatherback sea turtles (Aguirre et al. 1994; Caurant et al. 1999; Corsolini et al. 2000). Mckenzie et al. (1999) measured concentrations of chlorobiphenyls and organochlorine pesticides in sea turtle tissues collected from the Mediterranean (Cyprus, Greece) and European Atlantic waters (Scotland) between 1994 and 1996. Omnivorous loggerhead turtles had the highest organochlorine contaminant concentrations in all the tissues sampled, including those from green and leatherback turtles (Storelli et al. 2008). Dietary preferences were likely the main differentiating factor among species. Decreasing lipid contaminant burdens with turtle size were observed in green turtles, most likely attributable to a change in diet with age. Sakai et al. (1995) found the presence of metal residues occurring in loggerhead turtle organs and eggs. Storelli et al. (1998) analyzed tissues from twelve loggerhead sea turtles stranded along the Adriatic Sea (Italy) and found that characteristically, mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals and porpoises (Law et al. 1991).

Conservation and Recovery Actions Benefiting Sea Turtles
NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for Atlantic HMS and Gulf of Mexico reef fish fisheries, and TED requirements for the southeastern shrimp fisheries. These regulations have relieved some of the pressure on sea turtle populations.

Under Section 6 of the ESA, NMFS may enter into cooperative research and conservation agreements with states to assist in recovery actions of listed species. NMFS has agreements with the state of Florida. Prior to issuance of these agreements, the proposal must be reviewed for compliance with Section 7 of the ESA.

Other Actions
A revised recovery plan for the loggerhead sea turtle was completed December 8, 2008 (NMFS and USFWS 2008). Recovery teams comprised of sea turtle experts have been convened and are currently working towards revising other plans based upon the latest and best available information. Five-year status reviews have recently been completed for green and loggerhead sea turtles. These reviews were conducted to comply with the ESA mandate for periodic evaluation of listed species to ensure that their threatened or endangered listing status remains accurate. Each review determined that no delisting or reclassification of a species status (i.e., threatened or endangered) was warranted at the time. However, further review of species data for the green sea turtles was recommended, to evaluate whether DPSs should be established for this species (NMFS and USFWS 2007).

Summary and Synthesis of Environmental Baseline for Sea Turtles
In summary, several factors adversely affect sea turtles in the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action. Fisheries in the action area likely had the greatest adverse impacts on sea turtles in the mid to late 80s, when effort in most fisheries was near or at peak levels. With the decline of the health of managed species, effort since that time has generally been declining. Over the past 5 years, the impacts associated with fisheries have also been reduced through the Section 7 consultation process and regulations implementing effective bycatch reduction strategies. However, interactions with commercial and recreational fishing gear are still ongoing and are expected to occur contemporaneously with the proposed action. Other environmental impacts including effects of vessel operations, additional military activities, dredging, oil and gas exploration, permits allowing take under the ESA, private vessel traffic, and marine pollution have also had and continue to have adverse effects on sea turtles in the action area in the past.

5.2 Corals

5.2.1 Status of Listed and Proposed Corals within the Action Area
In Section 4.2.2, we described the range-wide status of listed and proposed corals. Within the Broward County, staghorn coral occurs in some of the largest densities within the U.S. Recent surveys conducted by the National Coral Reef Institute have identified 35 dense patches of staghorn coral between Hollywood and Fort Lauderdale. Seven patches are near previously known existing locations and 28 newly identified areas. Initial approximations of areal coverage suggest the sites totaled over 110,000 m^2 of previously unknown dense patches of staghorn coral. These new discoveries have the potential of more than tripling the area of previously documented staghorn coral (B. Walker, National Coral Reef Institute, pers. comm. to J. Karazsia, NMFS, October 21, 2013).

Within Broward County, all of the proposed corals occur in varying, but relatively low densities (Gilliam 2011). Recent surveys adjacent to the Port Everglades expansion indicate that 6 of the proposed corals as well as staghorn coral are present nearby the action area, see Table 3 (Gilliam and Walker 2011). Within the Port Everglades expansion area, knobby star coral, mountainous star coral, lobed star coral, elliptical star coral, rough cactus coral, and Lamarck's sheet coral occurs on the middle reef tract and outer reef tract adjacent to the channel and within the proposed extension and flare area.

Table 3. Summary Data for Staghorn and Proposed Coral Species Adjacent to Port Everglades (Gilliam and Walker 2011)

Species Name	Number of Colonies	Density (colonies/acre)
Acropora cervicornis	823	1.12
Agaricia lamarcki	912	1.24
Dichocoenia stokesii	376	0.51
Orbicella annularis	262	0.36
Orbicella faveolata	4030	5.48
Orbicella franksi	298	0.41
Mycetophyllia ferox	26	0.04

5.2.2 Factors Affecting Listed and Proposed Corals within the Action Area

Coral colonies are non-motile and susceptible to relatively localized adverse effects as a result. Localized adverse effects to listed and proposed corals in the action area are likely from many of the same stressors affecting these species throughout their range, namely ocean warming, ocean acidification, disease, anthropogenic breakage and intense weather events (i.e., hurricanes and extreme cold water disturbances). NMFS has completed a number of Section 7 consultations to address the effects of federal actions on staghorn corals, and when appropriate, has authorized the incidental taking of this species. Each of those consultations sought to minimize the adverse impacts of the action on staghorn coral. The summary below of federal actions and the effects of these actions includes only those federal actions in, or with effects within, the action area that have already concluded or are currently undergoing formal Section 7 consultation.

Federal Actions

Federal actions that may adversely affect listed and proposed corals in the action area include:

- **Commercial and recreational fisheries authorized by the National Marine Fisheries Service.** Certain types of fishing gear (e.g., hook-and-line, trap gear, nets) may adversely affect coral species. NMFS previously completed a biological opinion evaluating the impacts of Gulf of Mexico/South Atlantic spiny lobster fishery on *A. cervicornis*. The opinion concluded trap gear used in the fishery may adversely affect *A. cervicornis* corals via fragmentation/breakage and abrasion (primarily from storm mobilized trap gear), but those effects were not likely to jeopardize the species continued existence. NMFS is continuing to collect data to analyze the impacts of federal fisheries and will conduct ESA Section 7 consultations as appropriate.

EPA and USACE-permitted discharges to surface waters and dredge-and-fill. Shoreline and riparian disturbances (whether in the riverine, estuarine, marine, or floodplain environment) resulting in discharges may retard or prevent the reproduction, settlement, reattachment, and development of listed or proposed corals (e.g., land development and runoff, and dredging and disposal activities, result in direct deposition of sediment on corals, shading, and lost substrate for fragment reattachment or larval settlement). These activities can directly affect *A.*

cervicornis via fragmentation/breakage or abrasion. The activities may also affect listed and proposed coral species by physically altering or removing benthic habitat suitable for colonization. Dredge-and-fill activities may also cause increases in sedimentation that may cause shading, deposition of sediment onto coral colonies, and/or loss of substrate for fragment reattachment or larval settlement. The 1997 RBO is currently undergoing a reinitiation of consultation due to the listing of *A. cervicornis* and *A. palmata,* among other things.

- **EPA-regulated discharge of pollutants, such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens, or organic nutrient-laden water, including sewage water, into the waters of the United States.** Elevated discharge levels may cause direct mortality, reduced fitness, or habitat destruction/modification. The EPA has been involved in ongoing litigation over the sufficiency of standards promulgated by the State of Florida to regulate discharges of nutrients into state waters, including habitats occupied by the listed and proposed corals. NMFS is engaged in consultation with the EPA regarding their approval of the state's standards.

- **Coral Nurseries.** NMFS has issued 3 separate biological opinions for the establishment of staghorn coral nurseries and restoration projects within Broward County (one to Biscayne National Park, one to NMFS Habitat Conservation/Restoration Center, and one to The Nature Conservancy). The activities include collecting coral fragments and growing them within nurseries and then outplanting them onto the natural reefs. In all cases NMFS has determined that the nursery and restoration activities would not jeopardize the continued existence of staghorn corals.

Other Non-Federal Actions Affecting Listed and Proposed Corals.
Poor boating and anchoring practices, as well as poor diving and snorkeling techniques cause abrasion and breakage of *Acropora cervicornis*. Commercial and recreational vessel traffic can adversely affect listed and proposed corals through propeller scarring, propeller wash, and accidental groundings. Anthropogenic sources of marine pollution, while difficult to attribute to a specific federal, state, local or private action, may indirectly affect corals in the action area. Sources of pollutants in the action area include atmospheric loading of pollutants such as PCBs, storm water runoff from coastal towns, and runoff into canals and rivers that empty into bays and groundwater. Nutrients, contaminants, and sediment from point and non-point sources cause direct mortality and the breakdown of normal physiological processes. Additionally, these stressors create an unfavorable environment for reproduction and growth.

Nutrient loading from land-based sources, such as coastal communities and agricultural operations, are known to have adverse effects on corals. Lapointe et al. (2004) directly linked wastewater discharges in the Florida Keys with adverse effects to the nearby coral reef communities. Within the past 6 years, offshore wastewater outfalls in Broward County have been decommissioned, as part of implementation of Chapter 2008-232, Laws of Florida, which prohibits the construction of new domestic wastewater ocean outfalls, sets out a timeline for the elimination of existing domestic wastewater ocean outfalls by 2025, and requires that a majority of the wastewater previously discharged be beneficially reused. This law was enacted in part because of the adverse effects of effluent to corals.

Diseases have been identified as a major cause of coral decline. Although the most severe mortality resulted from an outbreak in the early 1980s, diseases (i.e., white band disease) are still present in *Acropora cervicornis* populations and continue to cause mortality.

Hurricanes and large coastal storms could also significantly harm *Acropora cervicornis*. Due to its branching morphology, it is especially susceptible to breakage from extreme wave action and storm surges. Historically, large storms potentially resulted in an asexual reproductive event, if the fragments encountered suitable substrate, attached, and grew into a new colony. However, in the recent past, the amount of suitable substrate is significantly reduced; therefore, many fragments created by storms die. Hurricanes are also sometimes beneficial, if they do not result in heavy storm surge, during years with high sea surface temperatures, as they lower the temperatures providing fast relief to corals during periods of high thermal stress (Heron et al. 2008). However, major hurricanes have caused significant losses in coral cover and changes in the physical structure of many reefs. According to the NOAA Historical Hurricane Tracks website, approximately, 29 hurricanes or tropical storms have impacted the area within 20 nautical miles of Fort Lauderdale, since records have been kept (1859-2013).

Several types of fishing gears used within the action area may adversely affect listed and proposed corals. Longline, other types of hook-and-line gear, and traps have all been documented as interacting with corals in general, though no data specific to listed corals are available. Available information suggests hooks and lines can become entangled in reefs, resulting in breakage and abrasion of corals. Traps have been found to be the most damaging; lost traps and illegal traps were found to result in greater impact to coral habitat because they cause continuous habitat damage until they degrade.

Conservation and Recovery Actions Benefiting Listed Corals

Research, restoration, and education and outreach activities, as part of the NMFS's ESA program, as well as through NOAA's Coral Reef Conservation Program (CRCP), are ongoing through the southeast region. NOAA's Restoration Center and state and territorial partners conduct grounding response and restoration activities throughout the U.S. jurisdictions. The summaries below discuss these measures in more detail.

Regulations Reducing Threats to Listed Corals

Numerous management mechanisms exist to protect corals or coral reefs in general. Prior to the ESA listing of elkhorn and staghorn corals, federal regulatory mechanisms and conservation initiatives most beneficial to branching corals have focused on addressing physical impacts, including damage from fishing gear, anchoring, and vessel groundings. NMFS has implemented a Section 4(d) rule to establish "take" prohibitions for listed corals. Such regulations are determined to be necessary and advisable to provide for the conservation of threatened species, and may prohibit many actions automatically prohibited for endangered species, including but not limited to: importing or exporting species from or into the United States; taking of species from U.S. waters, its territorial sea, or the high seas; or possessing or selling species. On October 29, 2008, NMFS published a final Section 4(d) rule extending all the Section 9 take prohibitions to listed elkhorn and staghorn corals. These prohibitions include the import, export, or take of elkhorn or staghorn corals for any purpose, including commercial activities. The 4(d) rule for listed *Acropora* has exceptions for some activities, including scientific research and species enhancement, and restoration carried out by authorized personnel.

In addition, the Coral Reef Conservation Act and the two Magnuson-Stevens Act Coral and Reef Fish Fishery Management Plans (Caribbean) require the protection of corals and prohibit the collection of hard corals. Depending on the specifics of zoning plans and regulations, marine protected areas (MPAs) can help prevent damage from collection, fishing gear, groundings, and anchoring.

The State of Florida regulates activities that involve and occur in coral reefs in Florida. Statutes and rules protect all corals from collection, commercial exploitation, and injury/destruction on the sea floor (FS 253.001, 253.04, Chapter 68B-42.008 and 68B-42.009), except as authorized by a Special Activity License for the purposed of research. Additionally, Florida has a comprehensive state regulatory program that regulates most land, including upland, wetland, and surface water alterations throughout the state.

Other Listed Coral Conservation Efforts

Recovery Planning and Implementation

A draft recovery plan for elkhorn and staghorn corals is required by a settlement agreement to be published no later than September 7, 2014. The recovery team is comprised of fishers, scientists, managers, and agency personnel from Florida, Puerto Rico, and U.S.V.I., and federal representatives. Similar plans will be identified for proposed coral species should the listings become finalized.

Even in the absence of a recovery plan, NMFS and its partners have implemented numerous recovery actions since the time of listing, consistent with NMFS's Recovery Outline for elkhorn and staghorn corals. Generally, these activities fall into the following categories:

- Monitoring and mapping
- Life history, disease, and threat impact research
- In-situ and ex-situ propagation and outplanting
- Reduction of and restoration of impacts from physical disturbances
- Reduction of impacts from land-based sources of pollution
- Outreach and education

Summary and Synthesis of Environmental Baseline for Listed and Proposed Corals

In summary, several factors are presently adversely affecting listed and proposed corals within the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action:

- Disease outbreaks
- Temperature-induced bleaching events
- Ocean acidification
- Major storm events
- Upland and coastal activities that will continue to degrade water quality and decrease water clarity necessary for coral growth
- Dredge-and-fill activities

- Interaction with fishing gear and adverse effects of fishing
- Vessel traffic that will continue to result in abrasion and breakage due to accidental groundings and poor anchoring techniques
- Poor diving and snorkeling techniques that will continue to abrade and break corals

These activities are expected to combine to adversely affect the recovery of staghorn and proposed corals throughout their ranges, and in the action area.

5.3 Status of Elkhorn and Staghorn Coral Designated Critical Habitat within the Action Area

In Section 4.2.6, we described the range-wide status of designated *Acropora* critical habitat. In summary, the Florida area of *Acropora* spp. critical habitat comprises approximately 1,329 square miles (3,442 sq km) of marine habitat offshore of Palm Beach, Broward, Miami-Dade, and Monroe counties, Florida, and encompasses the entire Florida Reef Tract beginning east of Palm Beach County and extending south along the Florida Keys. Within the action area, there are approximately 19,200 acres (~30 square miles) of designated critical habitat, which includes both the areas affected by the Port expansion and the areas associated with the blended mitigation plan (discussed in Consultation History section of this Opinion) in which the nurseries and outplanting sites will occur.

Factors Affecting Critical Habitat within the Action Area

Localized adverse effects to designated critical habitat in the action area are likely from many of the same stressors affecting the critical habitat throughout their range, namely activities that may increase turf- or macroalgal cover (i.e., releases of nutrients or reduction in herbivory) or increase sediment cover.

Federal Actions

Numerous activities funded, authorized, or carried out by federal agencies have been identified as threats and may affect elkhorn and staghorn corals' critical habitat in the action area. To date, however, few consultations on activities affecting critical habitat within the action area have been completed.

- **USACE-permitted dredge-and-fill activities.** The activities may impact critical habitat by physically altering or removing benthic habitat suitable for colonization. Dredge-and-fill activities may also cause increases in sedimentation that may cause loss of substrate for fragment reattachment or larval settlement. The 1997 RBO on navigation channel maintenance using hopper dredges is currently undergoing a reinitiation of consultation, to address the impacts of these activities on coral critical habitat among other things, and will evaluate the effects of certain dredge-and-fill activities that occur within the action area. In the past century, 3 major ports have been constructed in southeast Florida. A total of approximately 772 acres of coral reef habitat has been impacted via direct removal and burial (Walker et al. 2012a). Several beach renourishment projects have been completed in Broward County. In 2006, Segment III renourishment project resulted in over 43 acres of nearshore reef impacts via sediment burial (Prekel et al. 2008).

- **EPA-regulated discharge of pollutants, such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens, or organic nutrient-laden water, including sewage water, into the waters of the United States.** Elevated nutrients can lead to increased algal growth. The EPA has been involved in ongoing litigation over the sufficiency of standards promulgated by the State of Florida to regulate discharges of nutrients into state waters, including habitats occupied by the listed and proposed corals. NMFS is engaged in consultation with the EPA regarding their approval of the state's standards.

Other Non-Federal Actions Affecting Elkhorn and Staghorn Critical Habitat.
The State of Florida regulates activities that involve and occur in coral reefs in Florida. Statutes and rules protect all corals from collection, commercial exploitation, and injury/destruction on the seafloor (FS 253.001, 253.04, Chapter 68B-42.008 and 68B-42.009), except as authorized by a Special Activity License for the purposed of research. Therefore, the State regulates alterations to the reef. Additionally, Florida has a comprehensive state regulatory program that regulates most land, including upland, wetland, and surface water alterations throughout the state, resulting in regulation of land-based sources of nutrients or sediment that may adversely affect *Acropora* critical habitat.

Vessel groundings and anchor damage from commercial and recreational vessels within southeast Florida have historically resulted in severe negative impacts to the Florida Reef Tract. According to Sansgaard (2013) the Florida Department of Environmental Protection's (FDEP) Coral Reef Conservation Program (CRCP) has responded to, and managed, 124 of incidents related to vessel groundings and anchor damage. Typically only large vessel groundings alter the substrate to render it unconsolidated. However, several of the documented events have been large vessels. For example, in 2006, the M/V Clipper Lasco (a 645-ft cargo ship) grounded offshore of Fort Lauderdale resulting in over 6,000 square feet (ft^2) of reef impacted. However, due to the large number of vessel groundings in the area, the U.S. Coast Guard relocated the anchorage and no large vessel groundings have occurred since 2009.

Conservation and Recovery Actions Benefiting Coral Critical Habitat in the Action Area
The NOAA Coral Reef Conservation Program provides funding for several activities with an education and outreach component for informing the public about the importance of the coral reef ecosystem and the status of listed corals. The Southeast Regional Office of NMFS has also developed outreach materials regarding the listing of elkhorn and staghorn corals, the Section 4(d) regulations, and the designation of critical habitat. These materials have been circulated to constituents during education and outreach activities and public meetings, and as part of other Section 7 consultations, and are readily available on the website: http://sero.nmfs.noaa.gov/pr/esa/acropora.htm.

Numerous management mechanisms exist to protect corals and the habitats on which they grow, thus indirectly benefiting *Acropora* designated critical habitat. The Coral Reef Conservation Act and the two Coral and Coral Reef Fishery Management Plans under the Magnuson-Stevens Act require the protection of corals and prohibit the collection of hard corals. Depending on the specifics of zoning plans and regulations, marine protected areas (MPAs) can help prevent damage from collection, fishing gear, groundings, and anchoring; however, no MPAs occur within the action area.

5.4 Johnson's Seagrass

5.4.1 Status of Johnson's Seagrass within the Action Area

Based on the results of the southern transect sampling, it appears there is a relatively continuous, although patchy, distribution of the species from Jupiter Inlet to Virginia Key, at least during periods of relatively good environmental conditions and no significant large-scale disturbances (NMFS 2007).

The project area includes several small patches of Johnson's seagrass, mostly intermixed with other seagrass species. The majority of the seagrass found in the action area will not be affected by the project.

5.4.2 Factors Affecting Johnson's Seagrass within the Action Area

A wide range of activities funded, authorized, or carried out by federal agencies may affect the essential habitat requirements of Johnson's seagrass.

Federal Actions

- **Dock/Marina Construction, boat shows, bridge/highway construction, residential construction, and shoreline stabilization.** NMFS has consulted on numerous projects in or near the action area that have adversely affected Johnson's seagrass. The majority of these projects were single- or multi-family dock construction that resulted in a few hundred square feet of impacts to Johnson's seagrass. However, a few projects resulted in more significant impacts. Newer construction is encouraged to follow the NMFS-USACE dock construction guidelines and the Johnson's Seagrass Key in order to minimize shading impacts to Johnson's seagrass. NMFS and the USACE have covered many of the impacts to Johnson's seagrass in several programmatic biological opinions on regional general permitting activities, which ensure that issuance of the general permits as a whole are not likely to jeopardize the affected species.

- **EPA and the USACE permitted freshwater discharges into waterways**. Freshwater discharges can alter the salinity essential feature for Johnson's seagrass. Water quality and transparency within the range of Johnson's seagrass are affected by storm water and agricultural runoff, wastewater discharges, and other point and non-point source discharges. The most clearly identified and manageable threat to the survival and recovery of Johnson's seagrass is the possibility of mortality due to reduced salinity over long periods of time (NMFS 2007). High-volume freshwater discharges from Lake Okeechobee flow downstream to the mouth of the St. Lucie River and have the potential to adversely affect Johnson's seagrass. NMFS recently completed consultation with the USACE on the programmatic impacts of the Comprehensive Everglades Restoration Plan (CERP), which may help to alleviate the frequency of high-volume freshwater discharges from Lake Okeechobee to Johnson's seagrass habitats.

Other Non-Federal Actions Affecting Johnson's seagrass

Natural Disturbances
Large-scale weather events, such as tropical storms and hurricanes, while they often generate runoff conditions that decrease water quality, also produce conditions (wind setup and abrupt water elevation changes) that can increase flushing rates. The effects of storms can be complex. Specifically documented storm effects on healthy seagrass meadows have been relatively minor and include: (1) scouring and erosion of sediments; (2) erosion of seeds and plants by waves, currents, and surge; (3) burial by shifting sand; (4) turbidity; and (5) discharge of freshwater, including inorganic and organic constituents in the effluents (Oppenheimer 1963, van Tussenbroek 1994, Whitfield et al. 2002, Steward et al. 2006). Storm effects may be chronic, e.g., due to seasonal weather cycles, or acute, such as the effects of strong thunderstorms or tropical cyclones. Studies have demonstrated that healthy, intact seagrass meadows are generally resistant to physical degradation from severe storms, whereas damaged seagrass beds may not be as resilient (Fonseca et al. 2000, Whitfield et al. 2002). In the late summer and early fall of 2004, 4 hurricanes passed directly over the northern range of Johnson's seagrass in the Indian River Lagoon. A post-hurricane random survey in the area of the Indian River Lagoon affected by the 4 hurricanes indicated the presence of Johnson's seagrass was similar to that reported by the SJRWMD transect surveys prior to the storms. This indicates that while the species may temporarily decline, under the right conditions it can recover quickly (Virnstein and Morris 2007). Furthermore, despite evidence of longer-term reductions in salinity, increased water turbidity, and increased water color associated with higher than average precipitation in the spring of 2005, there was no evidence of long-term chronic impacts to seagrasses and no direct evidence of damage to Johnson's seagrass that could be considered a threat to the survival of the species (Steward et al. 2006).

State and Federal Activities That May Benefit Johnson's Seagrass
State and federal conservation measures exist to protect Johnson's seagrass and its habitat under an umbrella of management and conservation programs that address seagrasses in general (Kenworthy et al. 2006). These conservation measures must be continually monitored and assessed to determine if they will ensure the long-term protection of the species and the maintenance of environmental conditions suitable for its continued existence throughout its geographic distribution.

5.5 Summary and Synthesis of Environmental Baseline

In summary, several factors are presently adversely affecting green and loggerhead sea turtles, Johnson's seagrass, listed and proposed for listing corals, and designated critical habitat for elkhorn and staghorn corals in the action area. These factors are ongoing and are expected to occur contemporaneously with the proposed action:

- Interaction with commercial and recreational fishing gear
- Dredge-and-fill activities, including channel dredging and beach re-nourishment/restoration activities
- Runoff containing toxins and pollutants from land-based sources
- Disease outbreaks
- Major storm events
- Upland and coastal activities will continue to degrade water quality and decrease water clarity necessary for coral growth

- Poor vessel anchoring as well as poor diving and snorkeling techniques will continue to abrade and break corals

These activities are expected to combine to adversely affect the recovery of green and loggerhead sea turtles, Johnson's seagrass, and proposed and listed corals throughout their ranges, and in the action area.

6 Effects of the Action

As described below, NMFS believes that the proposed action may adversely affect loggerhead and green sea turtles, Johnson's seagrass, staghorn coral and corals proposed for listing under the ESA, and designated critical habitat for staghorn coral. Because the action will result in adverse effects to these species, we must evaluate whether the action is likely to jeopardize the continued existence of any of these species or likely to cause destruction or adverse modification to critical habitat.

6.1 Effects of the Action on Sea Turtles

In Section 3, we determined listed species of sea turtles likely to be adversely affected via any or all portions of the proposed action include green and loggerhead sea turtles. Potential routes of adverse effects of the proposed action on sea turtles are limited to hopper dredging.

Previous NMFS biological opinions have determined that hopper dredges may adversely affect loggerhead and green sea turtles through entrainment by the draghead. Hopper dredges will only be used to suction off accumulated shoal material from the existing. This may take anywhere from a few days to a few weeks depending on the amount of material that has shoaled into the entrance channel. Between 2005 and 2013 approximately 100,000 cy of material shoaled in the Port Everglades entrance channel (pers. comm. Terri Jordan-Sellers, USACE, to K. Logan, NMFS, February 2014). Assuming a similar amount of shoal material is to be removed by hopper dredge and assuming that the contractor uses a smaller, 3,000-cy-capacity hopper dredge (with an average load value of 2,500 cy), they would need to complete approximately 40 trips total to the ODMDS.

During dredging operations, protected species observers will live aboard the dredge, monitoring every load, 24 hours a day, for evidence of dredge-related impacts to protected species, particularly sea turtles. Observers will also maintain a bridge watch for protected species and keep a logbook noting the date, time, location, species, number of animals, distance and bearing from dredge, direction of travel, and other information, for all sightings. During all phases of dredging operations, the dredge and crew will be required to adhere to NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions*.

Since there has never been a reported sea turtle take from hopper dredging in Port Everglades, Port of Miami, or Key West, we relied on data from the nearest harbor with reported takes, Palm Beach Harbor, in order to estimate potential take by hopper dredges in the action area during the proposed 5-year dredging action. From 1994 through 2011, hopper dredging of the Palm Beach Harbor generated approximately 2,446,916 cy of material (Table 4). Eleven sea turtles were documented/observed as taken in hopper dredges during these dredging events. This equates to a catch per unit effort (CPUE) of 0.00000449 turtles per cubic yard dredged.

Table 4. Dredged Material Removed and Sea Tnrtle Takes Dnring Dredging in the Palm Beach Harbor, 1994-2011 (USACE Sea Turtle Data Warehouse 2014)

Year	Quantity of Dredged Material (Cubic yards) Palm Beach Harbor	Loggerhead	Green	Total Turtles
1994	181,338			
1995	179,330	3	2	5
1996	154,847	1	1	2
1997	219,177			
1998	73,349			
1999	64,779			
2000	187,340	1		1
2001	112,446			
2002	184,935			
2003	111,625	1		1
2004	343,770	1		1
2005	318,874	1		1
2006	70,698			
2007	12,000			
2008	157,828			
2009	43,735			
2010	64,068			
2011	66,777			
Total	2,446,916	8	3	**11**
CPUE	0.00000449			

Using this data we can calculate that the proposed project will take 0.45 turtles (0.00000449 X 100,000 = 0.45), rounded up to 1 turtle.

NMFS has previously determined that dredged material screening is only partially effective at detecting entrained turtles, and observed interactions likely provide only partial estimates of total sea turtle mortality. NMFS believes that some turtles killed by hopper dredges go undetected because body parts are forced through the sampling screens by water pressure and are buried in the dredged material, or animals are crushed or killed but their bodies or body parts are not entrained by the suction and so the interactions may go unnoticed. Mortalities are only noticed and documented when body parts float, are large enough to be caught in the screens, and can be identified as sea turtle parts. Body parts that are forced through the suction dragheads' 4-inch (or greater) inflow screens by the suction-pump pressure and that do not float are very unlikely to be observed, since they will sink to the bottom of the hopper and not be detected by the overflow screening.

Unobserved interactions are not documented, thus, observed interactions may under-represent actual lethal interactions. There may have been unobserved takes in previous dredging operations at Port Everglades.

It is not known how many turtles are killed but unobserved. Thus, to be conservative, in the 1993 Regional Biological Opinion on hopper dredging issued to the U.S. Army Corps of Engineers for their Gulf of Mexico District's (i.e., Jacksonville, Mobile, New Orleans, and Galveston) maintenance dredging and beach renourishment operations, NMFS estimated that up to 1 out of 2 impacted turtles may go undetected (i.e., that observed interactions constitute only 50% of total takes). We will apply this longstanding conservative assumption in the present opinion, since we have no new information that would change the basis of that previous conclusion and estimate. Therefore, our jeopardy analysis will account for total takes (observed takes plus undetected takes). Our Incidental Take Statement (ITS) is based on observed takes, not only because observed mortality gives us an estimate of unobserved mortality, but because observed, documented take numbers serve as triggers for some of the reasonable and prudent measures, and for potential reinitiation of consultation if actual observed takes exceed the anticipated/authorized number of observed takes.

Experience has shown that the vast majority of hopper-dredge impacted turtles are immediately killed by being crushed or through dismemberment from being trapped underneath and rolled under the heavy suction dragheads and/or by the violent forces they are subjected to during entrainment through the dredges' powerful, high-velocity dredge pumps. A very few turtles (over the years, a fraction of a percent) survive entrainment in hopper dredges, usually smaller juveniles that are sucked through the pumps without being dismembered or badly injured. Often they will appear uninjured only to die days later of unknown internal injuries, while in rehabilitation. Therefore, we are conservatively predicting that all takes by hopper dredges will be lethal.

As discussed above, NMFS estimates that there will be 2 incidental, lethal interactions (1 observed and 1 unobserved). Because more loggerheads were taken than greens in dredging activity in Palm Beach Harbor (approximately 2.5 times as many), we anticipate that the turtles taken will be loggerheads, but we cannot rule out that greens may be taken. Green sea turtles made up 27% of entrainments at Palm Beach Harbor hopper dredging. Given the growth of the green sea turtle population over the past decade and increased nesting of greens on Florida beaches, we believe green sea turtles are relatively more abundant in nearshore Florida waters than previously (see Figure 7). By comparison, the loggerhead population has not enjoyed the same rate of long-term increase (see Figure 6). Therefore, we believe that the observed take might well consist of 1 green or 1 loggerhead, and, for the purposes of this Opinion, that is our anticipated observed take by species. However, to be most conservative, in our jeopardy analysis, we will assume that both takes will occur to just reproductively mature females of just one species, i.e., that 2 loggerheads or 2 greens will be lethally taken.

6.2 Effects of the Action on Johnson's Seagrass

NMFS believes the proposed action is likely to adversely affect Johnson's seagrass, which is listed as threatened under the ESA. The ESA expressly provides only limited prohibitions on take of endangered plants (*See* ESA section 9(a)(2), 16 U.S.C. § 1538(a)(2)), and NMFS has not promulgated any 4(d) rule for Johnson's seagrass. Thus, take of Johnson's seagrass resulting from the proposed action is not prohibited, and no incidental take statement or reasonable and prudent measures will be issued. However, because the action will result in adverse effects to Johnson's seagrass, we must evaluate whether the action is likely to jeopardize the continued existence of the species.

Johnson's seagrass will be directly removed via dredging; no other types of effects, such as sedimentation, are expected to impact this species. Utilizing data from surveys conducted by Dial Cordy, Inc., in 2000, 2006, and 2009, we performed an independent GIS analysis to determine cumulative coverage of Johnson's seagrass. This approach is consistent with the methodology used by NOAA's Habitat Conservation office in determining seagrass impacts for this project. We determined that 4.67 acres of Johnson's seagrass will be permanently removed via dredging (see Table 5 and Figure 11).

Table 5. Cumulative Coverage of Johnson's Seagrass

	Cumulative Average Coverage (acres)
Johnson's Seagrass	4.379
Mixed Seagrass*	0.289
Total	4.668

*Mixed seagrass beds were calculated assuming 50% coverage of Johnson's seagrass. Transect data indicated a range of coverages from less than 1% to approximately 50%; therefore, to be conservative, we will use 50% for all the mixed beds.

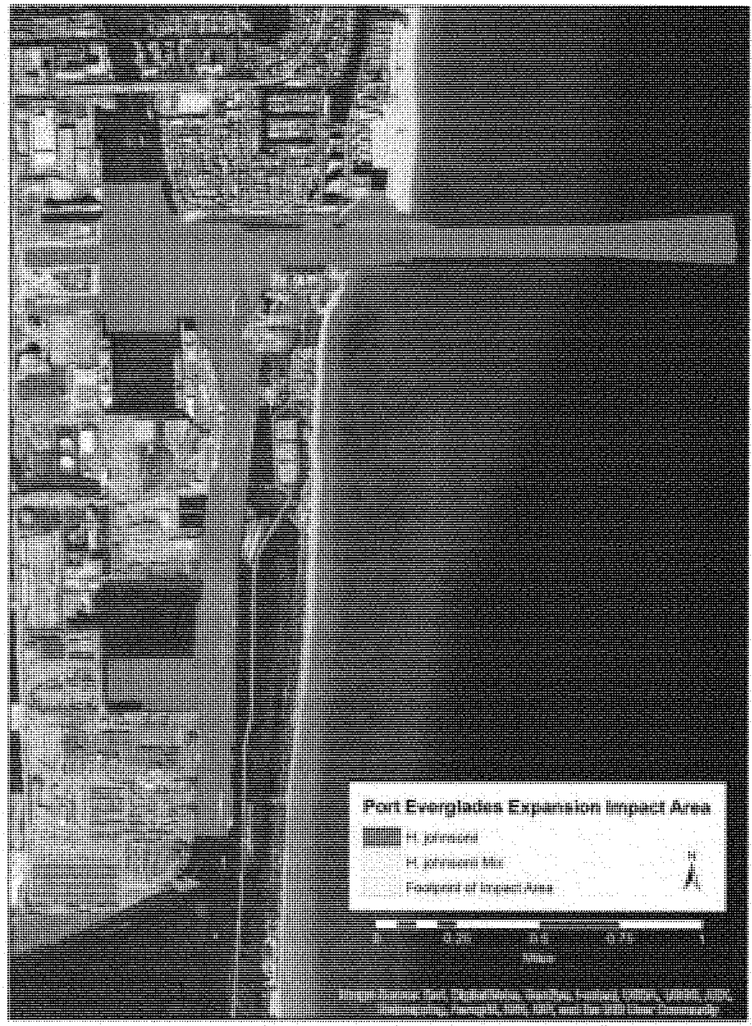

Figure 11. Johnson's seagrass within the project area

6.3 Effects of the Action on Coral Designated Critical Habitat

As described below, NMFS believes the proposed action will both adversely affect and benefit designated critical habitat for staghorn coral. The Florida area, which will be affected by the proposed action, comprises approximately 1,329 square miles of listed coral critical habitat. The physical feature essential to the conservation of staghorn coral is defined as substrate of suitable quality and availability, in water depths from mean high water to 30 m, to support larval settlement and recruitment, and reattachment of asexual fragments. Substrate of suitable quality and availability is defined as natural consolidated hardbottom or dead coral skeleton that is free from turf or fleshy macroalgae cover and sediment cover. We used hardbottom mapping data for south Florida (Walker et al., 2008b) to determine the amount of the critical habitat essential feature that could be affected by the project. Approximately 139 acres of coral critical habitat will be adversely affected by the project. Additionally, approximately 22 acres of reef will be populated with dense stands of staghorn coral as part of the blended mitigation plan, accelerating the conservation function of these areas of coral critical habitat. Based on these adverse and beneficial effects to critical habitat, we must evaluate whether the proposed action may result in the destruction or adverse modification of critical habitat; if so, NMFS must develop reasonable and prudent alternatives to avoid such impacts.

The Port Everglades Expansion project includes various types of impacts to coral reef and hardbottom habitats through directly dredging or blasting, anchoring and cable dragging, and sedimentation. To determine the nature and extent of impacts to coral critical habitat from the proposed action, we used Figure 12 below which has been adapted from Walker et al. (2008b) and includes the project boundaries (black lines) overlaid on the benthic habitat map produced by Dr. Walker (colored areas). The figure shows the dredge footprint (inner black lines) and the adjacent 150 meter area (outer black line). The area at the end of the channel (in yellow) includes the 6.11 acre area below the -57 ft dredge depth where we believe that fracturing and other impacts will occur from removing the reef structure above this depth. Hardbottom habitat types are identified and color coded, sand areas are indicated in grey. As indicated in Table 6, below, we believe that there will be permanent impacts from dredging and blasting to the habitat areas within the dredge footprint (channel) and sedimentation impacts (both permanent and temporary) to the area within 150 meters adjacent to the channel. Additionally, we believe there will be permanent impacts (fracturing, etc.) to the hardbottom area located along the outer reef tract, below the -57 ft dredge depth. Furthermore, there may be some additional anchor and cable drag impacts (potential impacts) to 19.31 acres of habitat within the 150 meters adjacent to the channel in the event that the USACE selects a contractor that will need to anchor outside of the channel[9].

[9] At this time the mitigation plan and incremental cost analysis is in draft form and may contain different inputs than what is analyzed in this Opinion. Impact estimates used in this Opinion are the most conservative to be consistent with the requirements of the ESA. Any changes made to the mitigation plan as a result of inputs used will not result in less than 38,254 staghorn colony outplants.

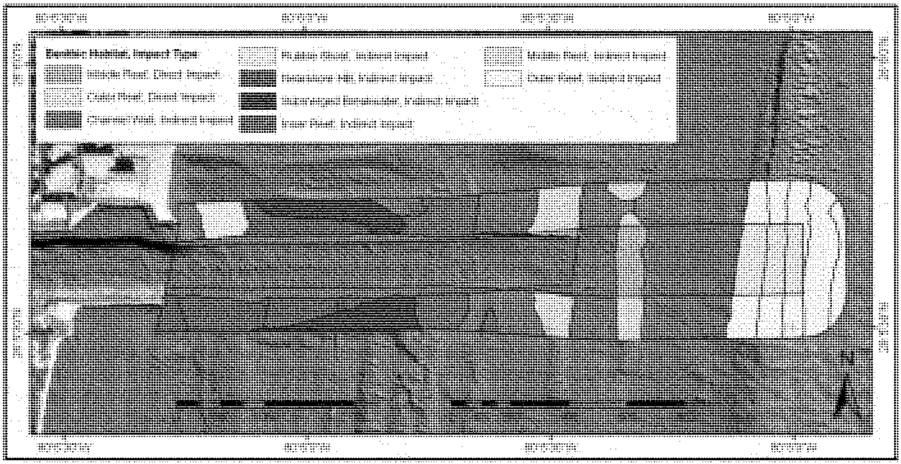

Figure 5. Coral reef habitat impact types within the Port Everglades Expansion Area (from Walker et al. 2008b)

Table 6 summarizes the types, area, and duration of effects to designated critical habitat for elkhorn and staghorn corals. The activities associated with the Port Everglades Expansion project will result in both permanent and temporary effects, as described below. In addition, some of the effects are certain or judged likely to occur (the "confirmed" and "predicted" impacts), while others are contingent upon the ultimate methods used by the contractor (the "potential" impacts). Because we must use a precautionary approach to analyzing effects, we will assume that the maximum potential adverse effects will occur.

Table 6. Summary of Adverse Effects to *Acropora* Designated Critical Habitat from the Port Everglades Expansion Project

Type of Impact	Duration	Area (acres)
Direct removal via explosives and dredging	Confirmed Permanent	15.55
Reef fracturing and sediment/rubble deposition	Confirmed Permanent	6.11
Anchor placement and drag	Potential Permanent	19.31
Sedimentation	Predicted Permanent	1.96
Sedimentation	Predicted Temporary	96.22
Total Impacts		**139.15**

While it may appear that coral reefs and hardbottom habitats are solid rock and extremely structurally stable, the opposite is actually true. Up to 40% of the reef structure may be void spaces because the reef is created by layering dead skeleton, other calcifying organisms, and sediments (Jaap et al. 2006). Therefore, reef and hardbottom (i.e., the essential feature of staghorn critical habitat) is susceptible to damage from physical impacts. The proposed project will permanently adversely affect 21.66 acres of designated critical habitat for staghorn coral. Approximately 15.55 acres of designated critical habitat will be adversely affected through direct removal of the essential feature by explosives and dredging of the middle and outer reef (Figure

12). The underlying reef framework (essential feature) will be permanently destabilized via fracturing and rubble formation, making this area unsuitable and unavailable for coral recruitment and growth. An additional 6.11 acres of critical habitat on the middle and outer reefs located below dredge depth of -57 ft will be impacted due to fracturing of the reef framework and downslope movement of sediments and rubble as a result of dredging. Fracturing the reef framework will permanently destabilize the essential feature rendering it unsuitable and unavailable for coral recruitment and growth. Further, depending on the size and density of the created rubble, it may stay within the impact area indefinitely, also making the area unsuitable for coral recruitment and growth. Similar impacts from ship groundings and explosive use have resulted in significantly lower recruitment rates compared to un-impacted adjacent reef (Fox et al. 2003; Piniak et al. 2010; Rubin et al. 2008). Therefore, we believe that a total of 21.66 acres of designated critical habitat will be permanently adversely affected by the dredging activities.

Based on benthic habitat maps (Walkeret al. 2008b) for the area (including the 150-m indirect impact zone adjacent to the existing channel), the project may potentially permanently impact up to an additional 19.31 acres of critical habitat adjacent to the channel via anchor placement and cable drag (Figure 12, indirect impact areas). The USACE does not anticipate that this impact will occur because the most cost-effective dredging methods will likely avoid these impacts. However, given the potential for these impacts, we are identifying how they may adversely affect critical habitat. Anchor placement and drag may result in the deconsolidation of the hardbottom, rendering it into rubble or smaller fragments. Such impacts can have lasting effects on the physical structure of the site and decrease its abiltiy to support coral recruitment and growth (Rogers and Garrison 2001). Thus, this area would no longer be suitable or available for coral recruitment or growth. So, should a dredging method be selected that results in anchor placement and cable drag, we believe that an additional 19.31 acres of designated critical habitat may be affected.

In addition to the permanent physical impacts from blasting, dredging and/or anchoring identified above, we predict another 98.09 acres of critical habitat in the 150 m areas adjacent to the channel will be impacted by sedimentation caused by dredging. The creation and resuspension of sediments during construction will result in sediment transport and deposition onto the essential feature, rendering it temporarily unsuitable and unavailable for coral recruitment and growth. Sedimentation affects larval settlement and recruitment, and fragment attachment. Sediment accumulation on dead coral skeletons and exposed hard substrate reduces the amount of available substrate suitable for coral larvae settlement and fragment reattachment. Even small increases in sedimentation can significantly reduce coral recruitment and survivorship (Babcock and Smith 2000), and sediments coupled with turf algae further impede recruitment (Birrell et al. 2005). Further supporting the impact sedimentation has on recruitment, coral larvae of some species settle preferentially on vertical surfaces to avoid sediments and cannot successfully establish themselves in shifting sediment (U.S. Army Engineer Research Development Center 2005). Last, survivorship of branching coral fragments is significantly affected by the type of substrate, with increased mortality being linked to the presence of sandy sediments (Lirman 2000). Therefore, if sediments are present and deposited on the area adjacent to the channel, critical habitat may be unavailable for coral larval and fragment recruitment and growth.

Even so, coral reefs are dynamic systems and sediments are often removed from the reef substrate by currents, tides, or storm events, especially those on exposed coasts like the Florida Reef Tract. The residence time of sediments is dependent on several factors including grain size and the hydrodynamics of the system (i.e., higher energy is needed to mobilize larger grained materials). According to the DEIS (USACE 2013), sediment constituents encountered at the Port vary greatly according to location and elevation. The majority of substrate materials within the dredging area include inter-bedded layers of sand and rock. A minority of the material includes silts, clays, and peat/organics. Approximately 80%-90% of the softer excavated rocks are classified as sands with mixed gravel. The harder materials are classified as boulders of varying size. Based on monitoring of nearby beach nourishment projects, it is likely that the impacts of sedimentation are likely to be temporary, with the majority of the area returning to suitable conditions after approximately 18 months (Prekel et al. 2008). Previous monitoring from dredge events at Key West and Port Everglades show no permanent impacts from sedimentation, but some NCRI scientists believe some permanent impacts due to sedimentation may occur from the proposed action. NMFS and USACE agreed meetings held in November 2013 that the majority of the sediment effects are likely to be temporary. To be conservative we will consider a maximum of 2% or 1.96 acres of the area predicted to be impacted by sedimentation will be permanently adversely affected and 96.22 acres of the area predicted to be impacted by sedimentation will only be temporarily adversely affected by dredging. Given that there are no elkhorn or staghorn corals in the area which could use this area for fragment or larvae settlement, we believe that the temporary effects from sedimentation to this 96.22 acres of critical habitat are insignificant.

While there are 133 acres of hard substrate along the bottom and walls of the existing channel, it does not provide the essential feature for *Acropora* settlement and recruitment. As discussed in the final rule designating critical habitat, we determined that existing federally-authorized channels do not provide the essential feature. This is based on the disturbed nature of the substrate within channels and channel walls (i.e., it has been dredged from its natural condition). Further, sediment movement, suspension, and deposition levels are high within existing channels. Hard substrate found within these channels and along their walls are ephemeral in nature and are frequently covered by sand or disturbed by maintenance dredging, thus not meeting the definition of the essential feature. Therefore, the impacts to the hardbottom that occurs in the channel bottom and channel walls are not considered impacts to *Acropora* critical habitat and thus are not part of our critical habitat impact analysis.

Depending on vessel operations and waterway safety, it may be necessary to temporarily or permanently move some or all of the fixed and floating ATONs within the project area (up to 20 total). If ATONs are moved temporarily, all relevant and applicable USCG ATON PDCs (project design criteria) and BMPs (best management practices) will be followed as laid out in NMFS's previous Biological Opinion to the USCG (SER-2011-3196) governing ATON placement and maintenance. This includes the temporary placement of ATONs in areas that are not likely to adversely affect endangered species or habitats. If ATONs are to be moved permanently based on considerations by the U.S. Coast Guard not related to this dredging project, independent consultation with NMFS will take place before the permanent placement of ATON. Generally, fixed ATONs will be removed and replaced with temporary floating ATONs during the dredge project to allow for contractor flexibility and safety of vessels transiting the waterway. The temporary floating ATONs will be placed on the fixed ATONs' prior assigned positions until consultation with NMFS is concluded. ATONs will be temporarily relocated within 30 ft of the existing channel, within the indirect impact zone. Therefore, we believe that effects from the temporary relocation of ATONs will insignificant.

The proposed project includes creation of 5 acres of boulder reef with approximately 12,500 corals relocated from within the dredge footprint. Because the boulder reefs will not be placed on the essential feature of critical habitat, we believe there will be no effect to critical habitat resulting from this activity.

The proposed project also includes enhancement of degraded reef sites with propagation and/or outplanting of additional corals, including 35,000-50,000 colonies of *Acropora cervicornis* at appropriate densities, as mitigation required by the USACE under its authorities to compensate for the impacts to corals and coral reefs. For purposes of this opinion, degraded reef sites are those that are not currently healthy coral dominated reefs due to a previous impact or environmental condition but that could easily be improved through outplanting activities; transplant sites will not include areas with ongoing environmental conditions that would prevent newly outplanted corals from surviving. A comprehensive transplantation and monitoring plan will be developed and approved by NMFS prior to construction to ensure the success of the propagation and outplanting portion of the project. We believe that this portion of the mitigation proposal will have a beneficial effect on designated critical habitat, by accelerating the provision of its intended conservations functions for staghorn coral. The following analysis shows how we determined that the propagation and outplanting component of the project would provide for the conservation of the species.

Facilitating increased incidence of successful sexual and asexual reproduction is the key objective to the conservation[10] of staghorn coral identified for its designated critical habitat (73 FR 72224, November 26, 2008), based on the species' life history characteristics, population declines, and extremely low recruitment. Therefore, the critical habitat designation identifies the essential feature within the areas occupied by the species that need protection to support that goal. Corals are sessile and depend upon external fertilization in order to produce larvae. Fertilization success is reduced as adult density declines (known as the Allee effect) (Levitan 1991). Since *Acropora* is not able to self-fertilize it requires a certain density (discussed in further detail below) of adult colonies to promote sexual reproduction (*Acropora* Biological Review Team 2005).

Another activity that supports the goal of increased incidence of successful sexual and asexual reproduction is artificial propagation of the species. The Recovery Outline for Elkhorn and Staghorn Coral (NMFS 2013) identifies the following key action necessary to promote conservation:

> *Develop and implement appropriate strategies for population enhancement, through restocking and active management, in the short to medium term, to increase the likelihood of successful sexual reproduction and to increase wild populations.*

[10] Under the ESA, conservation is equated with recovery of a species (i.e., the species no longer needs the protection of the ESA).

Numerous nurseries for staghorn coral have been established to support this recovery activity in the past 15 years with the expressed purpose of enhancing wild populations with sufficient densities of the species to promote natural sexual reproduction (Johnson et al. 2011). To date, hundreds of thousands of staghorn corals have been propagated and outplanted throughout the species' range, with high survival rates (i.e., 75%-90%; T. Moore, NOAA Restoration Center pers. comm. to J. Moore, NMFS PRD, January 22, 2014). Therefore, we are highly confident that propagation and outplanting of staghorn corals support the intended goal.

One of the objectives identified in the Recovery Outline is to ensure the population viability of each species. The NMFS *Acropora* recovery team, working on a draft recovery plan for elkhorn and staghorn corals, has determined that population viability for staghorn coral requires achieving a density of one colony ($\geq$ 0.5 m diameter in size) per square meter, throughout approximately 5% of consolidated reef habitat in 5-20 m water depth throughout the species' range (A. Moulding, NMFS Recovery Team liason pers. comm. To K. Logan, NMFS PRD, February 2014). Based on estimates of the proportion of habitat historically occupied by staghorn thickets, the recovery team has determined that this is the density of adult staghorn coral colonies necessary to facilitate sustained sexual reproduction. We assume that the maximum conservation potential of critical habitat can be calculated by applying this metric of a recovered population. Therefore, we applied this criterion to the area of critical habitat predicted to be permanently adversely affected by the proposed action, to calculate the number of colonies of certain size and density the area would have needed to support, to fulfill the population viability requirements identified by the recovery team. First we determined the proportion of the area that will be permanently adversely affected that would satisfy the habitat requirement, by calculating the acreage representing 5% of the permanently adversely affected area. This results in an area of 4,382.7 m^2 (5% of 23.62 acres = 1.181 acres = 4,779.34 m^2). To determine the size and density requirements, we considered that a colony 0.5 m in diameter will occupy 0.2 m^2 if we assume the colony is roughly circular in shape (area of a circle = $3.14 \times r^2 = 3.14 \times (0.25)^2 = 0.2$ m^2). Consequently, 0.2 m^2 coral occupancy per square meter of hardbottom is necessary to achieve the size and density goal identified by the recovery team, and to achieve full functionality of critical habitat. The staghorn colonies required to be outplanted by the blended mitigation agreement will be approximately 0.2 m (20 cm) in diameter. Therefore, again assuming the colonies are roughly circular in shape and applying the equation for the area of a circle, the area of an outplanted colony will be 0.03 m^2 ($3.14 \times (0.1)^2 = 0.03$ m^2). Consequently, approximately 7 colonies of staghorn coral per square meter of hardbottom would be required to provide the full conservation benefit of the critical habitat which will be permanently lost due to the project (0.2 m^2/0.03 m^2 = 6.67 colonies/m^2). This is consistent with data presented by Vargas-Angel et al. (2003), who have determined that the highest average cover in surveyed staghorn thickets was 25.9%, and the highest average density was 3.3 colonies per m^2 (average colony size 40.8 cm). Multiplying the habitat requirement calculated above (4,779.34 m^2) by the number of colonies needed per square meter (6.67 colonies) results in a total of 31,878 staghorn colonies. Further calculations regarding recruitment, mortality, and growth rates support this conclusion (see Appendix C).

6.4 Effects of the Action on Staghorn Coral

The blended mitigation plan includes using coral nurseries to grow and subsequently outplant between 35,000 and 50,000 colonies of staghorn coral at appropriate densities. Corals may be collected from existing nurseries or from "corals of opportunity" (i.e., unattached wild colonies or those proposed to be impacted by an authorized activity that can be rescued and relocated). Collecting coral fragments involves directed take (via collection) of *A. cervicornis*. However, the protective regulations pursuant to ESA Section 4(d) for staghorn provides for certain exceptions to the ESA Section 9 prohibitions for scientific research and species enhancement, and restoration carried out by authorized personnel (73 FR 64264; October 29, 2008). Thus, the take that may result from this project's propagation and outplanting of staghorn corals is currently not prohibited, as long as the actions are carried out pursuant to: (1) the exceptions in the 4(d) rule; and (2) the Biological Opinion on the issuance of the rule. Because all activities related to coral propagation (i.e., wild collection, nursery establishment and operation, and outplanting) in Broward County require a State of Florida Special Activity License (SAL), the USACE will be required to hold a valid permit (SAL) and they will be in compliance with the 4(d) rule. However, NMFS has proposed to reclassify staghorn coral from threatened to endangered and proposed to list 6 additional coral species that occur within the action area. Should that proposal become final (decision due June 2014), the aforementioned 4(d) rule for staghorn corals will be void because there are no exceptions to the take prohibitions allowed for endangered corals. Therefore, the take that will result from the propagation activities will need authorization. If the proposed reclassification is finalized in June 2014, the USACE will need to contact NMFS to determine the mechanism for authorizing the take of corals necessary to implement this action as proposed.

While the take of staghorn coral is not currently prohibited, we must still include the take that will result from coral nurseries in the evaluation of whether the proposed action will jeopardize the continued existence of the species.

Active coral propagation has been identified as a priority for staghorn coral by NMFS and by the *Acropora* Recovery Team. Over the course of the mitigation portion of the project, it is likely that fragments will be taken from fewer than 250 wild healthy colonies and brought into nurseries. The rest will be sourced from "corals of opportunity." Typically, collection of donor coral fragments is only necessary during the first year of a nursery. No additional coral collection is required after the first year of establishing a nursery since the nurseries produce enough coral tissue for both expansion and outplanting. Typically, approximately 20% of the corals in the nursery are designated to serve as broodstock while the remaining 80% will be outplanted. The broodstock corals are divided into multiple segments/fragments, which are maintained and grow in the nursery until they are ready to be outplanted.

NMFS believes that the collection of small fragments from wild *A. cervicornis* colonies will result in temporary effects on coral colonies. The collection of branch tip fragments from single staghorn coral colonies will result in a small reduction of coral colony biomass; however, this effect is expected to be temporary with recovery through tissue replacement and/or coral colony growth. *Acropora cervicornis*' dominant mode of reproduction is through asexual fragmentation. In the congener *Acropora palmata*, lesions at the point of fragment detachment have been shown to begin regeneration within 2 weeks of fragmentation (Lirman 2000), with regeneration rates being positively correlated with decreasing size of lesion and proximity to growing tip. The size of the lesion created in this project will be a function of the diameter of the branch being clipped. The diameter of staghorn coral branches ranges from 0.25 to 1.5 cm. Lirman (2000) showed that a 3-cm^2 lesion regenerated completely within 100 days. Given that the rate of recovery is an exponential decay, it is expected that lesions 0.25 to 1.5 cm in diameter (less than 2.25 cm^2) will recover much faster than in Lirman's experiment.

Furthermore, the proposed collection of fragments from *A. cervicornis* colonies will occur at the outermost portion of the branch tip of the coral colony. Soong and Lang (1992) observed that, in *A. cervicornis*, large polyps and basal tissues located 1.0 to 4.5 cm from the colony base were infertile, and larger eggs were located in the mid-region of colony branches. Gonads located within 2 to 6 cm of the colony's branch tips always had smaller eggs than those in the mid-region (Soong and Lang 1992). Larger colonies (as measured by surface area of the live colony) have higher fertility rates (Soong and Lang 1992). Thus, the effect of this activity on coral colony reproduction is insignificant. Given that the collected tissue samples are small in size (~20 cm) relative to coral colony size, that the effects of collecting such fragments are temporary, that fragmentation is a natural reproductive mode, and that these fragments will be collected from the outermost portion of the coral branch tip where smaller eggs are found, it is not likely that survival or reproductive output of staghorn coral colonies will be measurably reduced by the collection of staghorn fragments for nursery propagation.

The blended mitigation plan estimates that between 35,000 and 50,000 colonies of staghorn coral will be produced and outplanted to degraded reef sites, in the sizes and densities discussed above as needed to facilitate sustained, successful sexual reproduction. These colonies will supplement the wild populations within Broward County. Successful sexual reproduction is a goal of the recovery outline and identified as the key conservation goal of the critical habitat designation for staghorn (and elkhorn) corals. The purpose of outplanting staghorn coral into the wild is to enhance the wild population and provide additional potential for successful sexual reproduction. Outplanting will achieve the proper density and provide a source of varied genetic material which will increase the likelihood of sexual reproduction. Therefore, the survival and reproductive potential of staghorn coral will be enhanced by this action.

6.5 Effects of the Action on Proposed Coral Species

The analyses in this section are based upon the best available biological data on the proposed coral species and the effects of the proposed action. Data pertaining to effects from the proposed action relative to interactions with proposed species are limited. In such circumstances, we are often forced to make assumptions to overcome the limits in our knowledge. Frequently, different analytical approaches may be applied to the same data sets. In those cases, in keeping with the direction from the U.S. Congress to resolve uncertainty by providing the "benefit of the doubt" to threatened and endangered species [House of Representatives Conference Report No. 697, 96th Congress, Second Session, 12 (1979)], we will generally select the value yielding the most conservative outcome (i.e., the value which would lead to conclusions of higher, rather than lower, risk to endangered or threatened species).

We believe the proposed project will adversely affect 6 coral species that are proposed to be listed under the ESA (elliptical star coral, Lamarck's sheet coral, rough cactus coral, mountainous star coral, knobby star coral, and lobed star coral). Table 7 summarizes our estimates of the number of colonies of each proposed coral species that occur in the direct and indirect impacts areas. These estimates were calculated by applying the average species densities based on survey data provided by Dial Cordy, Inc. to each of the impact areas. In order to estimate the numbers of *O. annularis, O.fanksi,* and *O. faveolata* (because the Dial Cordy survey only identified the *Orbicella* complex) we applied the species densities from the study completed by Gillam and Walker (2011) to the total number of *Orbicella* complex identified in the Dial Cordy, Inc. survey area. The Dial Cordy, Inc. survey was only conducted in the middle- and out-reef areas. No surveys have been conducted within the channel bottom and channel walls. Therefore, to be conservative we are applying the densities of the proposed corals from the middle and outer reefs to the channel and channel wall hardbottom. However, it is unlikely that the proposed corals occur at the same densities as on the reef itself. Due to the shipping activity in the channel, there is likely much poorer water quality conditions within the channel as compared to the reef. Therefore, we assume the coral densities are likely much lower. Further, the channel has been dredged within the last 30 years. Given the relatively slow growth rates of the proposed corals, it is likely that the colonies that do exist within the channel and channel walls are smaller sizes than those on the reef. Thus, we anticipate that the estimates we provide for mortality of proposed corals within the channel and channel walls are likely an overestimate; however, it is the best available information and provides a conservative assessment of impacts to the species.

Table 7. Estimated Proposed Coral Colonies Within the Impact Area

Proposed Coral Species	Mortality (Middle and Outer Reef <57ft 15.55 ac)	Relocation Survival (Middle and Outer Reef 15.55 ac)	Relocation Mortality (Middle and Outer Reef 15.55 ac)	Mortality (Middle and Outer Reef >57ft 6.11 ac)	Mortality (Channel Bottom and Walls 153 ac)	Mortality (Indirect Impact Area 1.96 acres)	Mortality Total
Lamarck's sheet	0	35	6	16	352	5	379
Elliptical star	1522	105	19	646	14,071	207	16465
Lobed star	1121	773	657	792	17,238	254	20062
Mountainous star	36	25	21	29	24	517	627
Knobby star	36	25	21	29	24	517	627
Rough cactus	82	35	6	48	1,055	16	1207

We assume that all the proposed corals that occur in impact areas other than the middle and outer reef shallower than 57 ft will be killed as a result of the dredging operations. The USACE has proposed to relocate all proposed corals greater than or equal to 10 cm longest linear dimension from the middle and outer reef impact areas shallower than 57 ft.

Even though the relocation of proposed coral colonies involve directed take (collection), the USACE has proposed the relocation because the effect to the species is significantly reduced as compared to the level of almost certain lethal take of the proposed coral that would occur through direct removal via dredging, anchor placement, and cable drag. Relocations will result in: (1) a high likelihood of continued survival of the coral transplants, (2) the survival of the unique genetic material of the transplanted colonies, and (3) the potential for use of the material in future restoration activities. The Consultation Handbook (USFWS and NMFS 1998) expressly authorizes such directed take as an RPM (see page 4-53). Therefore, NMFS will evaluate the expected level of take through relocation so that these levels can be included in the evaluation of whether the proposed action will jeopardize the continued existence of the species.

Coral transplantation can successfully relocate colonies that would likely suffer injury or morality if not moved. Thornton et al. (2000) documented a 13% mortality rate for transplanted scleractinian corals in southeast Florida. The high rate of survival is attributed to the methods used and life history of corals. Lindahl (2003) showed that skilled handling does not significantly affect coral fragments or, by extension, coral colonies. Many different species of coral have shown high survival after transplantation, provided that colonies are handled with skill, are reattached properly, and the environmental conditions at the reattachment site are conducive to their growth (Maragos 1974, Birkeland et al. 1979, Harriott and Fisk 1988, Hudson and Diaz 1988, Guzman 1991, Kaly 1995, Becker and Mueller 1999, Tomlinson and Pratt 1999, Hudson 2000, Lindahl 2003, NCRI 2004).

The USACE and NMFS agree that all of the colonies of elliptical star, mountainous star, knobby star, lobed star, rough cactus, and Lamarck's sheet coral could be lethally taken during dredging if not relocated. Therefore, the USACE is proposing to relocate all colonies over 10 cm. We believe coral transplantation will be highly successful and relocating these corals outside the project area is an appropriate alternative to the take that would otherwise occur. The corals will be transplanted to the newly created artificial reef nearby the proposed project. Corals will be transplanted using the appropriate transplantation protocols (see Appendix B) by properly trained personnel. Corals will be placed on the artificial reef in area appropriate densities and grouped by species. Because suitable transplantation habitat is nearby and proper handling techniques are available and will be required, we have confidence that transplantation survival rates similar to those noted elsewhere will be likely in this case. We believe that a 15% coral morality rate of these corals being transplanted from their natural environment to areas nearby is a reasonable estimate; therefore, we anticipate an 85% survival rate of transplanted colonies.

The mitigation plan also includes the propagation and outplanting of corals to compensate for the impacts to corals and coral reef habitats. This portion of the mitigation plan is not finalized; therefore, it is unknown if any of the proposed species will be affected by this activity. None of the proposed coral species is currently in active propagation in any of the existing coral nurseries in Broward County. As described in Section 6.4, coral propagation and outplanting is beneficial to corals despite the initial take required to begin the nursery operations. Therefore, should any of the proposed species be propagated as part of the mitigation plan, the effects to them would also be beneficial.

In summary, we estimate that a maximum of 379 colonies of Lamarck's sheet coral, 16,465 colonies of elliptical coral, 20,062 colonies of lobed coral, 627 colonies of mountainous coral, 627colonies of knobby star coral, and 1207 colonies of rough cactus coral will be lethally taken during dredging activities. We also estimate that a maximum of 35 colonies of Lamarck's sheet coral, 105 colonies of elliptical coral, 773 colonies of lobed coral, 25 colonies of mountainous coral, 25 colonies of knobby star coral, and 35 colonies of rough cactus coral will be relocated and survive.

7 Cumulative Effects

Cumulative effects include the effects of *future* state, tribal, or local private actions – i.e., that are not already in the baseline -- that are reasonably certain to occur in the action area considered in this opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA (50

CFR 402.14). Actions that are reasonably certain to occur would include actions that have some demonstrable commitment to their implementation, such as funding, contracts, agreements or plans.

NMFS is aware of several future projects that may contribute to cumulative effects. Broward County is planning to begin construction on a mangrove enhancement project directly adjacent to the proposed Port expansion project. The County and Port also plan to expand the turning notch under a separate project. These activities will impact mangroves and may also impact Johnson's seagrass and sea turtles depending on the final construction methodology.

Within the action area, major future changes are not anticipated in addition to the ongoing human activities described in the environmental baseline. The present human uses of the action area, such as commercial shipping, are expected to continue, though some may occur at increased levels, frequency or intensity in the near future.

8 Jeopardy Analysis

The analyses conducted in the previous sections of this opinion provide the basis on which we determine whether the proposed action would be likely to jeopardize the continued existence of green and loggerhead sea turtles, Johnson's seagrass, staghorn coral, and corals proposed for ESA listing. In Section 6, we outlined how the proposed action would affect these species at the individual level and the magnitude of those effects based on the best available data. Next, we assess each of these species' response to the effects of the proposed action, in terms of overall population effects, and whether those effects will jeopardize their continued existence in the context of the status of the species (Section 4), the environmental baseline (Section 5), and the cumulative effects (Section 7).

It is the responsibility of the action agency to "insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species..." (ESA Section 7(a)(2)). Action agencies must consult with and seek assistance from the NMFS to meet this responsibility. NMFS must ultimately determine in a Biological Opinion whether the action jeopardizes listed species. To *jeopardize the continued existence of* is defined as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). The following jeopardy analysis first considers the effects of the action to determine if we would reasonably expect the action to result in reductions in reproduction, numbers, or distribution of loggerhead and green sea turtles, Johnson's seagrass, staghorn coral, or proposed coral species. The analysis next considers whether any such reduction would in turn result in an appreciable reduction in the likelihood of survival of these species in the wild, and the likelihood of recovery of these species in the wild.

8.1 Green Turtles

The potential lethal take of up to 2 green sea turtles (1 observed and 1 unobserved) by hopper dredge is a reduction in numbers. These lethal takes would also result in a potential reduction in future reproduction, assuming some individuals would be females and would have survived otherwise to reproduce. All life stages are important to the survival and recovery of sea turtles; however, it is important to note that individuals of one life stage are not equivalent to those of other life stages. For example, the take of male juveniles may affect survivorship and recruitment rates into the reproductive population in any given year, and yet not significantly reduce the reproductive potential of the population. A very low percent of hatchlings is typically expected to survive to reproductive age. The death of mature, breeding females can have an immediate effect on the reproductive rate of the species. Sublethal effects on adult females may also reduce reproduction by hindering foraging success, as sufficient energy reserves are probably necessary for producing multiple clutches of eggs in a breeding year. Different age classes may experience varying rates of mortality and resilience. Further, an adult green sea turtle can lay 1-7 clutches (usually 2-3) of eggs every 2-4 years, with 110-115 eggs/nest of which a small percentage is expected to survive to sexual maturity. Green sea turtles are highly migratory, and individuals from all Atlantic nesting populations may range throughout the Gulf of Mexico, Atlantic Ocean, and Caribbean Sea. Because all the potential interactions are expected to occur at random throughout the proposed action area and sea turtles generally have large ranges in which they disperse, the distribution of green sea turtles in the action area is expected to be unaffected.

To be conservative, we assume that the green sea turtles that will be taken will be reproductive females, with a higher potential impact on the species relative to take of other stages. If the take is of a reproducing female, it is likely that such a turtle is part of the Florida population (female returning to nesting beach).

This species is currently showing a very large increasing nesting trend in Florida, with nesting numbers already approaching or exceeding those required by the recovery plan for the species. Therefore, we believe that the reduction in numbers and reproduction as a result of the lethal take is not expected to appreciably reduce the likelihood of survival of green sea turtles in the wild.

We also considered the recovery objectives in the recovery plan prepared for the U.S. populations of green sea turtles that may be affected by the predicted reduction in numbers and reproduction. The recovery plan for green sea turtles (NMFS and USFWS 1991) lists the following relevant recovery objectives relevant to the effects of the proposed action:

• The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years. Nesting data must be based on standardized surveys. Between 2001 and 2006, an average of 5,039 green turtle nests were laid annually in Florida, with a low of 581 in 2001 and a high of 9,644 in 2005 (NMFS and USFWS 2007a). That average increased to 7,436 nests per year for the 6-year period of 2004-2009. Data from the index nesting beach program in Florida support the dramatic increase in nesting. In 2007, there were 9,455 green turtle nests found just on index nesting beaches, the highest since index beach monitoring began in 1989. The number fell back to 6,385 in 2008, but that is thought to be part of the normal biennial nesting cycle for green turtles (FWC Index Nesting Beach Survey Database). An additional drop to just below 3,000 nests was seen on the index nesting beaches in 2009, but the occasional break from the normal biennial pattern is not without precedent, as there were 2 consecutive years of increase from 2003-2005 (FWC Index Nesting Beach Survey Database). State nesting data for 2011 show an increase in green turtle nests to 10,701, the highest number of nests since 1988 (FWRI Web site: http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/).

• A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds. Currently, there are no reliable estimates of the number of immature green sea turtles that inhabit coastal areas (where they come to forage) of the southeastern United States. However, information on incidental captures of immature green sea turtles at the St. Lucie Power Plant (they have averaged 215 green sea turtle captures per year since 1977) in St. Lucie County, Florida, show that the annual number of immature green sea turtles captured has increased significantly in the past 26 years (FPL 2002). Ehrhart et al. (2007) has also documented a significant increase in in-water abundance of green turtles in the Indian River Lagoon area.

The lethal take of 2 turtles will result in a reduction in numbers and reproduction, but will not have any detectable influence on the population and nesting trends noted above. The loss of 2 individuals will not have an appreciable impact on total recruitment of new sea turtles to the population given the extent of the impact versus the very rapid population increases occurring over the past decade. Thus, the proposed action will not interfere with achieving the recovery objectives above and will not result in an appreciable reduction in the likelihood of green sea turtles' recovery in the wild.

8.2 Loggerhead Turtles (NWA DPS)

The potential lethal take of up to 2 loggerhead sea turtles (1 observed and 1 unobserved) by hopper dredge is a reduction in numbers. These lethal takes would also result in a reduction in reproduction as a result of lost reproductive potential, as some of these individuals would be females who would have survived other threats and reproduced in the future, thus eliminating each female individual's contribution to future generations. All life stages are important to the survival and recovery of sea turtles; however, it is important to note that individuals of one life stage are not equivalent to those of other life stages. For example, the take of male juveniles may affect survivorship and recruitment rates into the reproductive population in any given year, and yet not significantly reduce the reproductive potential of the population. A very low percent of hatchlings is typically expected to survive to reproductive age. The death of mature, breeding females can have an immediate effect on the reproductive rate of the species. Sublethal effects on adult females may also reduce reproduction by hindering foraging success, as sufficient energy reserves are probably necessary for producing multiple clutches of eggs in a breeding year. Different age classes may experience varying rates of mortality and resilience. Further, an adult female loggerhead sea turtle can lay 3-4 clutches of eggs every 2-4 years, with 100 to 130 eggs per clutch. The annual loss of adult female sea turtles, on average, could preclude the production of thousands of eggs and hatchlings of which a small percentage would be expected to survive to sexual maturity. A reduction in the distribution of loggerhead sea turtles is not expected from lethal takes during the proposed action. Because all the potential interactions are expected to occur at random throughout the proposed action area and sea turtles generally have large ranges in which they disperse, the distribution of loggerhead sea turtles in the action area is expected to be unaffected.

Whether or not the reductions in loggerhead sea turtle numbers and reproduction attributed to the proposed action would appreciably reduce the likelihood of survival for loggerheads depends on what effect these reductions in numbers and reproduction would have on overall population sizes and trends, i.e., whether the estimated reductions, when viewed within the context of the environmental baseline and status of the species, are of such an extent that adverse effects on population dynamics are appreciable. In Section 3.2.2, we reviewed the status of the species in terms of nesting and female population trends and several recent assessments based on population modeling [i.e., (Conant et al. 2009; NMFS-SEFSC 2009d)]. Below we synthesize what that information means in general terms and also in the more specific context of the proposed action.

Loggerhead sea turtles are a slow growing, late-maturing species. Because of their longevity, loggerhead sea turtles require high survival rates throughout their life to maintain a population. In other words, late-maturing species cannot tolerate much anthropogenic mortality without going into decline. Conant et al. (2009) concluded loggerhead natural growth rates are small; natural survival needs to be high; and even low to moderate mortality can drive the population into decline. Because recruitment to the adult population is slow, population modeling studies suggest even small increased mortality rates in adults and subadults could substantially impact population numbers and viability (Chaloupka and Musick 1997; Crouse et al. 1987; Crowder et al. 1994; Heppell et al. 1995).

The best available information indicates that the NWA loggerhead DPS is still large, but is possibly experiencing more mortality than it can withstand. All of the results of population models in both NMFS SEFSC (2009d) and Conant et al. (2009) indicated western North Atlantic loggerheads were likely to continue to decline in the future unless action was taken to reduce anthropogenic mortality. With the inclusion of newer nesting data beyond the 2007 data used in those analyses, the status of loggerhead nesting is beginning to show improvement. As previously described in the Status of the Species section, in 2008 nesting numbers were high, but not enough to change the negative trend line. Nesting dipped again in 2009, but rose substantially in 2010. With the addition of data through 2010, the nesting trend for the NWA DPS of loggerheads is only slightly negative and not statistically different from zero (no trend) (NMFS and USFWS 2010). Additionally, although the best fit trend line is slightly negative, the range from the statistical analysis of the nesting trend includes both negative and positive growth (NMFS and USFWS 2010). The 2011 nesting was on par with 2010, providing further evidence that the nesting trend may have stabilized and the 2012 index nesting number was the largest since 2000.

To be conservative, we assume that the loggerhead sea turtles that will be taken will be reproductive females, with a higher potential impact on the species relative to take of other stages.

NMFS SEFSC (2009d) estimated the minimum adult female population size for the western North Atlantic in the 2004-2008 time frame to likely be between 20,000 to 40,000 (median 30,050) individuals, with a low likelihood of being as many as 70,000 individuals. Estimates were based on the following equation: Adult females = (nests/(nests per female)) x remigration interval. The estimate of western North Atlantic adult loggerhead female was considered conservative for several reasons. The number of nests used for the western North Atlantic was based primarily on U.S. nesting beaches. Thus, the results are a slight underestimate of total nests because of the inability to collect complete nest counts for many non-U.S. nesting beaches. In estimating the current population size for adult nesting female loggerhead sea turtles, NMFS SEFSC (2009d) simplified the number of assumptions and reduced uncertainty by using the minimum total annual nest count over the relevant 5-year period (2004-2008) (i.e., 48,252 nests). This was a particularly conservative assumption considering how the number of nests and nesting females can vary widely from year to year (cf., 2008's nest count of 69,668 nests, which would have increased the adult female estimate proportionately, to between 30,000 and 60,000). In addition, minimal assumptions were made about the distribution of remigration intervals and nests per female parameters, which are fairly robust and well known parameters. Florida's long-term loggerhead nesting data (1989-2012) has shown three distinct trends. Following a 23% increase between 1989 and 1998, nest counts declined sharply for over a decade. During the period between the high-count nesting season in 1998 and the most recent (2012) nesting season, researchers found no demonstrable trend, indicating a reversal of the post-1998 decline. The overall change in counts from 1989 to 2012 is positive. Nest counts in 2012, corrected for subtle variation in survey effort, were slightly below the high nest count recorded in 1998.

Based on the total numbers of adult females estimated by NMFS SEFSC for the western North Atlantic population of loggerhead sea turtles, the anticipated lethal take of 2 loggerheads – in the extremely unlikely worst case that both are female and adult –resulting from the proposed action would represent the removal of approximately 0.006% ([2/30,000] x 100) of the estimated adult loggerhead female population. These removals are very small and contribute only minimally to the overall mortality on the population. Further, these percentages are likely an overestimation of the impact of the anticipated lethal take resulting from the proposed project on loggerhead sea turtles for the following reason. These percentages represent impacts to adult female loggerhead sea turtles only, and not to the population as a whole. Because this estimated contribution to mortality is a tiny part of our range of uncertainty across what total mortality might be for loggerhead sea turtles, we believe that the small effect posed by the lethal take resulting from the proposed project will not result in a detectable or appreciable reduction in the species' likelihood of survival in the wild.

We also considered the recovery objectives in the recovery plan prepared for the U.S. populations of loggerhead sea turtles that may be affected by the predicted reduction in numbers and reproduction. The Services' recovery plan for the Northwest Atlantic population of the loggerhead turtle (NMFS and USFWS 2009), which is in essence the same population of turtles as comprise the NWA DPS, provides explanation of the goals and vision for recovery for this population. The objectives of the recovery plan most pertinent to the threats posed by dredging associated activities are numbers 11 and 13:

11. Minimize trophic changes from fishery harvest and habitat alteration…
13. Minimize vessel strike mortality.

As discussed above, the proposed action will remove several acres of foraging habitat for sea turtles; however, the project area is surrounded by abundant seagrass meadows and the channel slopes will be recolonized by epifauna and flora once the dredging has concluded. Therefore, there will be insignificant effects from permanent loss of habitat that may have been used for foraging by sea turtles. Thus, the action will not interfere with achieving Objective 11. The take predicted from the action is entrainment of turtles by hopper dredges and thus does not constitute vessel strike mortality as envisioned in the recovery plan. Further, the proposed action is expected to reduce the level of vessel traffic using the inlet and harbor (fewer, larger vessels are anticipated). Further, since some of the larger vessels are already coming in at high tide with the narrow channels, there is a greater chance of turtles being struck since turtles don't have adequate room to move away from an oncoming ship. The widening and deepening should help to provide more room for turtles to avoid ships. Thus, the proposed action will not interfere with achieving Objective 13.

The recovery plan anticipates that, with implementation of the plan, the western North Atlantic population will recover within 50 to 150 years, but notes that reaching recovery in only 50 years would require a rapid reversal of the declining trends of the Northern, Peninsular Florida, and Northern Gulf of Mexico Recovery Units. The potential lethal take of 2 loggerheads during the project will result in reduction in numbers when take occurs and possibly by lost future reproduction, but given the magnitude of these trends and likely large absolute population size, it is unlikely to have any detectable influence on the population objectives and trends noted above. Loggerhead nest counts on Florida's index beaches have declined from a peak of nearly 60,000 in 1998. However, 2011 counts were close to the average of the previous 5 years. Although this may be the beginning of a stabilizing trend, additional good nesting years will be required to reverse the preceding decline (FWRI Web site: http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/).

Thus, the proposed action will not interfere with achieving the recovery objectives and will not result in an appreciable reduction in the likelihood of loggerhead sea turtles' recovery in the wild.

8.3 Johnson's seagrass

The estimated loss of up to 4.67 acres of Johnson's seagrass due to the proposed action is a conservative, reasonable worst-case scenario. The actual amount is likely much lower, but to be conservative, we assumed that all of the mixed beds contained 50% coverage of Johnson's seagrass. The loss of 4.67 acres of Johnson's seagrass is a reduction in numbers of the species. However, in terms of adverse effects on a larger, population scale, the Johnson's Seagrass Recovery Team determined that effects of dredging and filling activities are generally local and small -scale in nature and are not considered threats to the survival and recovery of the species. These activities will not individually or cumulatively result in the long -term, large -scale mortality of Johnson's seagrass, particularly in light of its "pulsating patches" life history strategy, discussed above. Thus, although up to 4.67 acres of Johnson's seagrass will be lost in the immediate action area, the project will not result in any adverse effects on a larger, population scale.

Reproduction will be reduced by the up to 4.67-acre reduction in Johnson's seagrass numbers, but NMFS considers that this reproductive loss does not appreciably reduce the likelihood of survival of Johnson's seagrass in the wild. Johnson's seagrass will continue to reproduce and spread because the proposed impacts are localized and will not affect any Johnson's seagrass outside of the dredge footprint. Johnsons's seagrass exists in the Dania Cutoff Canal, south of the action area, and will not be impacted.

The proposed action will not result in a reduction of Johnson's seagrass distribution or fragmentation of the range since we expect Johnson's seagrass will persist outside of the action area (in the Dania Cutoff Canal to the south) and will continue to be capable of spreading via asexual fragmentation. Therefore, the reproductive potential of the species in this portion of its range will persist.

Recovery for Johnson's seagrass, as described in the recovery plan, will be achieved when the following recovery objectives are met: (1) the species' present geographic range remains stable for at least 10 years, or increases; (2) self-sustaining populations are present throughout the range at distances less than or equal to the maximum dispersal distance to allow for stable vegetative recruitment and genetic diversity; and (3) populations and supporting habitat in its geographic range have long-term protection (through regulatory action or purchase acquisition).
NMFS believes that the proposed action will not appreciably reduce the likelihood of recovery of Johnson's seagrass in the wild. NMFS' s 2007 5-year review of the status of the species concluded that the first recovery objective has been achieved. In fact, the range has increased slightly northward. The proposed action will not impact the status of this objective. Self-sustaining populations are present throughout the range of the species. The species' overall reproductive capacity will be only minimally reduced by the reduction in Johnson's seagrass numbers and reproduction resulting from the action. The proposed dredging will not lead to separation of self -sustaining Johnson's seagrass patches to an extent that might lead to adverse effects to one or more patches of the species. Similarly, the availability of suitable habitat in which the species can spread/flow in the future will not be adversely affected by the proposed action. While additional individual impacts may continue to occur, over the last decade the species has not demonstrated any declining trends. The proposed action will not reduce or destabilize the present range of Johnson's seagrass. Therefore, the project will not appreciably reduce the likelihood of recovery of Johnson's seagrass in the wild.

8.4 Staghorn and Proposed Corals

In the following analysis, we evaluate the effects of the lethal take and nonlethal relocation of proposed corals from the Port Everglades Channel and the nonlethal collection of staghorn coral fragments for propagation and outplanting. Over the course of the Port Expansion activities and the 7-year mitigation project, we do not expect the proposed action to have any measurable impact on the reproduction, numbers, or distribution of the species.

As discussed in Section 6 (Effects of the Action), the expansion of Port Everglades is likely to adversely affect a maximum of 379 colonies of Lamarck's sheet coral, 16,465 colonies of elliptical coral, 20,062 colonies of lobed coral, 627 colonies of mountainous coral, 627colonies of knobby star coral, and 1207 colonies of rough cactus coral, by lethal take during dredging activities. However, the majority of the lethal take results from estimating the number of colonies that occur within the channel. We also estimate that a maximum of 35 colonies of Lamarck's sheet coral, 105 colonies of elliptical coral, 773 colonies of lobed coral, 25 colonies of mountainous coral, 25 colonies of knobby star coral, and 35 colonies of rough cactus coral will be relocated and survive.

The proposed action may also collect up to 250 fragments from wild colonies of staghorn coral and collect approximately 2,500 staghorn coral fragments of opportunity to support the propagation and outplanting portion of the mitigation plan.

We must now determine if the action would reasonably be expected to appreciably reduce, either directly or indirectly, the likelihood of staghorn coral or any of the proposed coral's survival and recovery in the wild.

Proposed Corals
Since the final listing has not yet been published, a recovery plan is not available for any of the proposed species. However, we can assess the effects of the proposed action on each of the proposed coral's populations in the context of our knowledge of the statuses of the species and their environmental baselines.

Lamarck's Sheet Coral.
The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 379 colonies would result in a reduction in Lamarck's sheet coral distribution in the immediate action area. However, the species is found throughout the wider Caribbean region. In Florida, Lamarck's sheet coral is found from Palm Beach County through Monroe County. The action area for this project is located in the middle of this range. The proposed action will not result in a reduction of Lamarck's sheet coral distribution or fragmentation of the range since we expect Lamarck's sheet coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in Lamarck's sheet coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species, such as substrate availability, community structure, grazing pressure, fecundity, mode, and timing of reproduction. The anticipated loss of 379 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in Lamarck's sheet coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the Lamarck's sheet coral colonies occur in the smaller size classes and no corals were observed larger than 40-cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5-1 cm/yr) we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of Lamarck's sheet corals in the wild.

An estimated maximum of 379 colonies of Lamarck's sheet coral will be lethally taken during dredging activities. While we do not have exact population estimates for this species, a high number of colonies are believed to be still in existence through the species' range. *Agaricia lamarcki* has been reported to be common (Veron, 2000). A 2011 survey conducted by Nova Southeastern University just south of Port Everglades has identified 912 colonies of Lamarck's sheet coral over just 735 acres. On reefs at 30–40 m depths in the Netherlands Antilles, *Agaricia lamarcki* has increased (Bak and Nieuwland, 1995) or shown no decline in abundance from 1973 to 1992 (Bak et al. 2005), even though other non-agariciid corals on the same deep reefs have decreased. However, it is unknown whether this relative stability at depth holds across the full range of the species. As compared to the range-wide population estimates, the potential loss of 379 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for *Agaricia lamarcki* include the potential losses of this species to bleaching or disease (Brainard et al. 2011). When bleaching occurs for this species, effects can be severe; the species also likely has limited sediment tolerance. A factor that reduces extinction risk is that it occurs primarily at great depth, where disturbance events are less frequent. Despite low rates of sexual recruitment, the species is relatively persistent compared to other deep corals. The proposed project would not cause an increase in disease or bleaching. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of Lamarck's sheet coral recovery in the wild.

Elliptical Star Coral

The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 16,465 colonies would result in a reduction in elliptical star coral distribution in the immediate action area. However, the species is found throughout the Caribbean, the Gulf of Mexico, Florida (including the Florida Middle Grounds), the Bahamas, and Bermuda (Brainard et al. 2011). In Florida, elliptical star coral has been recorded in the Florida Keys National Marine Sanctuary, Flower Garden Banks, National Marine Sanctuary, and Biscayne National Park. The action area for this project is located in the middle of this range. The proposed action will not result in a reduction of elliptical star coral distribution or fragmentation of the range since we expect that elliptical star coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in elliptical star coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 16,465 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in elliptical star coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the elliptical star coral colonies occur in the smaller size classes and no corals were observed larger than 40 cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5-1 cm/yr) we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of elliptical star corals in the wild.

An estimated maximum of 16,465 colonies of elliptical star coral will be lethally taken during dredging activities. While we do not have exact population estimates for this species, a high number of colonies are believed to be still in existence through the species' range. The overall colony density of *Dichocoenia stokesi* averaged across all habitat types in the south Florida region was ~ 1.6 colonies per 10 m^2, making it the ninth most abundant coral species in this region (Wagner et al., 2010). A 2011 survey conducted by Nova Southeastern University just south of Port Everglades has identified 5,514 colonies of elliptical star coral over just 735 acres. As compared to the range-wide population estimates, the potential loss of 16,465 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for *Dichocoenia stokesi* include its documented population-level impacts from disease. The proposed project would not cause an increase in disease. Factors that reduce potential extinction risk are its relatively high abundance and persistence across many habitat types, including nearshore and mesophotic reefs. Residency in a wide range of habitat types suggests the species has a wide tolerance to environmental conditions and, therefore, better capacity to deal with changing environmental regimes. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of elliptical star coral recovery in the wild.

Lobed Star Coral
The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 20,062 colonies of lobed star coral colonies would result in a reduction in lobed star coral distribution in the immediate action area. However, the species is common throughout U.S. waters of the western Atlantic and greater Caribbean, including Florida and the Gulf of Mexico. Within its range it is found within federally protected waters in the Flower Garden Bank Sanctuary, Dry Tortugas National Park, Virgin Islands National Park/Monument, Biscayne National Park, Florida Keys National Marine Sanctuary, Navassa National Wildlife Refuge, and the Buck Island Reef National Monument. The proposed action will not result in a reduction of lobed star coral distribution or fragmentation of the range since we expect that lobed star coral will persist within the action area due to relocation of colonies

(from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in lobed star coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 20,062 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in lobed star coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the lobed star coral colonies occur in the smaller size classes and no corals were observed larger than 40-cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5 -1 cm/yr) we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of lobed star corals in the wild.

While it is now widely accepted that *O. annularis* is only 1 of 3 valid species (the others being *O. franksi and O. faveolata*), long-term monitoring data sets and previous ecological studies did not distinguish among them, referring instead to the *Orbicella* complex. Although the biological review team that conducted the status review that resulted in the proposal to list these species estimated extinction risk separately for each species, much of the information available is for the complex as a whole (Brainard et al. 2011). An estimated maximum of 20,062 colonies of lobed star coral will be lethally taken during dredging activities. There is ample evidence that it has declined dramatically throughout its range (but perhaps at a slower pace than its fast-paced Caribbean colleagues, *Acropora palmata* and *Acropora cervicornis*). However, the *Orbicella* complex has historically been a dominant species on Caribbean and Florida coral reefs, characterizing the so-called “buttress zone” and “annularis zone” in the classical descriptions of Caribbean reefs (Goreau, 1959). Therefore, we believe that, even with the recent declines, there are still high numbers of lobed star coral throughout its range. As compared to the range-wide population estimates, the potential loss of 20,062 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for lobed star coral include very low productivity (growth and recruitment), documented dramatic declines in abundance, its restriction to the degraded reefs of the wider Caribbean region, and its preferential occurrence in shallow habitats. The proposed project would not increase any of these threats. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of lobed star coral recovery in the wild.

Mountainous Star Coral
The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 627 colonies of mountainous star coral colonies would result in a reduction in mountainous star coral distribution in the immediate action area. However, the species is common throughout U.S. waters of the western Atlantic and greater Caribbean, including Florida and the Gulf of Mexico. Within its range it is found within federally protected waters in the Flower Garden Bank Sanctuary, Dry Tortugas National Park, Virgin Islands National Park/Monument, Biscayne National Park, Florida Keys National Marine Sanctuary, Navassa National Wildlife Refuge, and the Buck Island Reef National Monument. The proposed action will not result in a reduction of mountainous star coral distribution or fragmentation of the range since we expect that mountainous star coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in mountainous star coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 627 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in mountainous star coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the mountainous star coral colonies occur in the smaller size classes and no corals were observed larger than 40-cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5 -1 cm/yr) we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of mountainous star corals in the wild.

While it is now widely accepted that *O. faveolata* is only 1 of 3 valid species (the others being *O. franksi and O. annularis*), long-term monitoring data sets and previous ecological studies did not distinguish among them, referring instead to the *Orbicella* complex. Although the biological review team has estimated extinction risk separately for each species, much of the information available is for the complex as a whole (Brainard et al. 2011). An estimated maximum of 627 colonies of mountainous star coral will be lethally taken during dredging activities. There is ample evidence that it has declined dramatically throughout its range (but perhaps at a slower pace than its fast-paced Caribbean colleagues, elkhorn and staghorn corals [*Acropora palmata* and *Acropora cervicornis*]). However, the *Orbicella* complex has historically been a dominant species on Caribbean and Florida coral reefs, characterizing the so-called "buttress zone" and "annularis zone" in the classical descriptions of Caribbean reefs (Goreau, 1959). Therefore, we believe that even with the recent declines that there are still high numbers of mountainous star coral throughout its range. A 2011 survey conducted by Nova Southeastern University just south of Port Everglades has identified 4,030 colonies of mountainous star coral over just 735 acres. As compared to the range-wide population estimates, the potential loss of 627 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for mountainous star coral include very low productivity (growth and recruitment), documented dramatic declines in abundance, its restriction to the degraded reefs of the wider Caribbean region, and its preferential occurrence in shallow habitats. The proposed project would not increase any of these threats. Therefore, NMFS believes that the proposed action is not likely to reduce the chances of mountainous star coral recovery in the wild.

Knobby Star Coral

The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 627 colonies of knobby star coral colonies would result in a reduction in knobby star coral distribution in the immediate action area. However, the species is is common throughout U.S. waters of the western Atlantic and greater Caribbean, including Florida and the Gulf of Mexico. Within its range it is found within federally-protected waters in the Flower Garden Bank Sanctuary, Dry Tortugas National Park, Virgin Islands National Park/Monument, Biscayne National Park, Florida Keys National Marine Sanctuary, Navassa National Wildlife Refuge, and the Buck Island Reef National Monument. The proposed action will not result in a reduction of knobby star coral distribution or fragmentation of the range since we expect that knobby star coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in knobby star coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction. We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 627 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in knobby star coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the knobby star coral colonies occur in the smaller size classes and no corals were observed larger than 40 cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5-1 cm/yr), we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of knobby star corals in the wild.

While it is now widely accepted that *O. franksi* is only 1 of 3 valid species (the others being *O. faveolata and O. annularis*), long-term monitoring data sets and previous ecological studies did not distinguish among them, referring instead to the *Orbicella* complex. Although the biological review team has estimated extinction risk separately for each species, much of the information available is for the complex as a whole (Brainard et al. 2011). An estimated maximum of 627 colonies of knobby star coral will be lethally taken during dredging activities. There is ample evidence that it has declined dramatically throughout its range (but perhaps at a slower pace than its fast-paced Caribbean colleagues, *Acropora palmata* and *Acropora cervicornis*). However, the *Orbicella* complex has historically been a dominant species on Caribbean and Florida coral reefs, characterizing the so-called "buttress zone" and "annularis zone" in the classical descriptions of Caribbean reefs (Goreau, 1959). Therefore, we believe that even with the recent declines that there are still high numbers of knobby star coral throughout its range. As compared to the range-wide population estimates, the potential loss of 627 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for knobby star coral include very low productivity (growth and recruitment), documented dramatic declines in abundance, its restriction to the degraded reefs of the wider Caribbean region, and its preferential occurrence in shallow habitats. The proposed project would not increase any of these threats. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of knobby star coral recovery in the wild.

Rough Cactus Coral

The proposed action will not affect the species' current geographic range. Since relocated colonies will remain in the same area, no change in species distribution is anticipated. The anticipated mortalities of up to 1,207 colonies of rough cactus coral colonies would result in a reduction in rough cactus coral distribution in the immediate action area. However, *Mycetophyllia ferox* occurs throughout the U.S. waters of the western Atlantic but has not been reported from Flower Garden Banks (Hickerson et al., 2008). Within its range it is found within federally-protected waters in the Dry Tortugas National Park, Virgin Islands National Park/Monument, Biscayne National Park, Florida Keys National Marine Sanctuary, Navassa National Wildlife Refuge, and the Buck Island Reef National Monument. The proposed action will not result in a reduction of rough cactus coral distribution or fragmentation of the range since we expect that rough cactus coral will persist within the action area due to relocation of colonies (from the impact area to the artificial reef area) and will continue to be capable of reproducing. Therefore, the reproductive potential of the species in this portion of its range will persist.

Although no change in rough cactus coral distribution was anticipated, we concluded lethal takes would result in a reduction in absolute population numbers that may also reduce reproduction.

We believe these reductions are unlikely to appreciably reduce the likelihood of survival of the species in the wild, because the action will not negatively affect critical metrics of the status of the species. The anticipated loss of 1,207 colonies would reduce the population by that amount, compared to the number that would have been present in the absence of the proposed action, assuming all other variables remained the same. Therefore, the action will result in a reduction in rough cactus coral reproduction, but would not have a measurable effect on the distribution of the species within the Florida unit or throughout its range.

According to the resource surveys conducted by Dial Cordy, Inc., the majority of the rough cactus coral colonies occur in the smaller size classes and no corals were observed larger than 40-cm longest linear dimension. Reproductive potential is positively correlated with colony size. In the species for which we have estimates of size at first reproduction, all are larger than 40 cm (average ~100 cm). Thus, we assume that these corals are not currently reproductive. Further, given the relatively slow growth rates of the proposed corals (~0.5 -1 cm/yr), we do not anticipate that these colonies would reach reproductive maturity over the duration of the project (i.e., 5 years). Therefore, we believe that the proposed project will not result in a reduction in reproduction of rough cactus corals in the wild.

An estimated maximum of 1,207 colonies of rough cactus coral will be lethally taken during dredging activities. Mycetophyllia ferox is usually uncommon (Veron, 2000) or rare according to published and unpublished records, indicating that it constitutes < 0.1% species contribution (percent of all colonies censused) and occurs at densities < 0.8 colonies per 10 m^2 in Florida (Wagner et al., 2010) and at 0.8 colonies per 100 m transect in Puerto Rico sites sampled by the Atlantic and Gulf Rapid Reef Assessment (AGRRA database online at http://www.agrra.org). Recent monitoring data (e.g., since 2000) from Florida (National Park Service permanent monitoring stations), La Parguera (Puerto Rico), and St. Croix (USVI/NOAA Center for Coastal Monitoring and Assessment randomized monitoring stations) show *Mycetophyllia ferox* cover to be consistently less than 1%, with occasional observations up to 2% and no apparent temporal trend (available online at http://www8.nos.noaa.gov/biogeo_public/query_habitat.aspx). Given the amount of reef tract in Florida, even at <0.8 colonies per 10m^2 there is still likely to be a high number of rough cactus coral colonies throughout Florida and even higher numbers throughout the range. As compared to the range-wide population estimates, the potential loss of 1,207 colonies would cause no noticeable change in the population of the species. Therefore, we believe the proposed action will not reduce appreciably the likelihood of survival in the wild.

Factors that increase the extinction risk for *Mycetophyllia ferox* include disease and rare abundance. Limited available information suggests that this species suffered substantial population declines in recent decades, primarily as a result of coral disease. The proposed project would not increase coral disease. Therefore, NMFS believes that the proposed action is not likely to reduce the likelihood of mountainous star coral recovery in the wild.

Staghorn Coral

The blended mitigation plan involves directed (intentional) take of coral fragments from up to 250 colonies of staghorn coral and collection of up to 2,500 "coral fragments of opportunity."

Although a recovery plan has not been finalized at this time for staghorn coral, we consider the recovery vision statement from the *Acropora* Recovery Outline (available at http://sero.nmfs.noaa.gov/pr/protres.htm) relevant to analyze the effects on recovery:

> Staghorn (and elkhorn) coral populations should be large enough so that reproducing individuals comprise numerous populations across their historical geographic range (wider Caribbean) and additionally, should be large enough to protect the species' genetic diversity. Threats to the species and habitat loss and degradation will be sufficiently abated to ensure a high probability of survival into the future.

No reduction in numbers, reproductive potential, or distribution of staghorn coral will result from the proposed actions. The directed take through fragment collection from up to 250 wild staghorn colonies will result in temporary impacts to the donor colony and will not result in the removal of any whole colonies. Corals of opportunity collected for propagation and outplanting would have likely otherwise died since they are unattached to the seafloor (e.g., as a result of ship groundings or storm events). Staghorn fragments collected from either source will be propagated and outplanted to degraded reefs within the action area. Therefore, there will be no reduction in numbers of staghorn coral. Rather, through the proposed action, there will be an increase in numbers of staghorn coral.

The collection of small fragments from the branch tips of staghorn coral is not anticipated to have any effect on the sexual or asexual reproduction of the donor colonies. Coral fragments are not collected during the summer months when the corals are producing eggs and sperm. The growing tip heals quickly and regains its reproductive potential quickly also. As stated above, corals of opportunity would likely have died without collection; therefore, collection results in preservation of the reproductive potential of the fragment. Last, the collected fragments will be propagated and outplanted resulting in an increase of reproductive output as compared to the potential the fragment had prior to collection. NMFS does not believe the proposed action is likely to impede staghorn coral's ability to reproduce sexually due to the loss or impacts to the reproductive capacity.

The proposed action is not expected to result in any lethal take of staghorn coral. We have determined that the directed take through fragment collection from up to 250 wild staghorn colonies will result in temporary impacts to the donor colony and will not result in the removal of any whole colonies. Collection of corals of opportunity will not reduce the species range, as these colonies would have died without having been collected. Further, the collected fragments will be propagated within nurseries and outplanted within the same geographic area (Broward County). Therefore, we believe that there would be no measurable effect on the distribution of the species throughout its range. The proposed action will not result in a reduction of numbers, reproduction, or distribution of staghorn corals. Hence, we have determined that the proposed action is not expected to appreciably reduce the likelihood of survival and recovery of these coral species in the wild.

9 Analysis of Destruction or Adverse Modification of Designated Critical Habitat

Critical habitat was designated for elkhorn and staghorn corals, in part, because further declines in the low population sizes of the species could lead to threshold levels that make the chances for recovery low. More specifically, low population sizes for these species could lead to an Allee effect and lower effective density (of genetically distinct adults required for sexual reproduction), and a reduced source of fragments for asexual reproduction and recruitment. In other words, a staghorn coral mate may be too far away for successful sexual reproduction to occur. Therefore, the key conservation objective of designated critical habitat is to facilitate increased incidence of successful sexual and asexual reproduction (i.e., increase the potential for sexual and asexual reproduction to be successful), which in turn facilitates increases in the species' abundance, distribution, and genetic diversity. To this end, our analysis of whether the proposed action is likely to destroy or adversely modify designated critical habitat seeks to determine if the adverse effects of proposed action on the essential features of designated *Acropora* critical habitat will appreciably reduce the capability of the critical habitat to facilitate an increased incidence of successful sexual and asexual reproduction. This analysis takes into account the current status of each species; for example, the level of increased incidence of successful reproduction that needs to be facilitated may be different depending on the recovery status of elkhorn and staghorn corals in the action area. This analysis also takes into account the geographic and temporal scope of the proposed action, recognizing that functionality of critical habitat necessarily means that it must currently and in the future continue to support the conservation of the species and progress toward recovery.

The key objective for the conservation and recovery of listed coral species identified for the designated critical habitat is the facilitation of an increase in the incidence of sexual and asexual reproduction. Recovery cannot occur without protecting the essential feature of critical habitat from destruction or adverse modification because the quality and quantity of suitable substrate for listed corals affects their reproductive success. The proposed action will result in the permanent loss of up to 23.62 acres of critical habitat via direct removal, fracturing and rubble creation, and sedimentation. Therefore, this portion of critical habitat will be permanently unavailable and unsuitable for coral recruitment.

As described in Section 6.3 above, the permanently affected portion of the critical habitat has the conservation potential of supporting up to 31,878 colonies of staghorn coral. This conservation potential would be realized if the area was eventually occupied by that number of colonies, which is dependent on several biological and physical factors that affect future success of staghorn corals colonizing these particular reefs. At the time of the critical habitat designation, and given the severely decreased abundance and depressed sexual reproduction of staghorn and elkhorn corals, NMFS determined it was necessary to include all of the essential feature (i.e., settlement substrate) that occurs in each critical habitat area within the designation, to maximize the potential that successful recruitment could occur. However, on finer scales, not every portion of critical habitat has the exact same conservation potential at any given time. The critical habitat within the project area is subject to wave action and pollution from constant large vessel traffic (i.e., physical and chemical barriers to conservation potential of the critical habitat).

Furthermore, there are currently no visible staghorn colonies within or near the permanently affected critical habitat (Dial Cordy, Inc. 2006) which would be capable of providing gametes for sexual reproduction (i.e., there currently exists a biological barrier to the conservation potential of the critical habitat). Therefore, we believe that the critical habitat within the dredge footprint would not achieve the density of adult staghorn colonies necessary to facilitate sexual reproduction (i.e., the conservation potential) during the construction timeframe of the project (up to 10 years) and potentially not soon after construction, given the completed project may exacerbate the physical and chemical barriers to recruitment discussed above.

The blended mitigation plan will likely use existing permitted coral nurseries which could supply colonies of suitable size (20 cm or greater) immediately. Even if colonies were not immediately available, it would take less than 1 year to grow corals to the appropriate size and begin outplanting. In either case, outplanting is expected to be implemented several years before the project construction impacts would occur. The above calculations indicate the minimum number of staghorn colonies necessary to immediately attain and maintain the density and coverage area recommended to achieve the population-based goals identified by the recovery team, and therefore also, the number of colonies necessary to provide the maximum conservation potential of the permanently adversely affected critical habitat area. However, this assumes 100% survival of outplanted colonies and no partial mortality. The assumption that no mortality will occur is unrealistic based on observations of approximately 75%-90% survival of outplants. Therefore, we assume a 20% increase in the number of required outplanted colonies (20% of 31,878 = 6,376 additional colonies) to buffer against loss from sources of mortality such as disease, predation, and stochastic events. Thus, accounting for the number of colonies needed to meet the population goal and the number of colonies needed to buffer against mortality, 38,254 colonies (31,878 + 6,376 = 38,254) of the size and density described above, are necessary to fully realize the conservation potential of the permanently affected area.

As stated above, we do not believe that the critical habitat in the dredge footprint will meet the conservation goal within the lifetime of the project, if ever. The propagation and outplanting will achieve the maximum conservation benefit of appropriate numbers and densities of adult staghorn colonies within 7 years. Also, the number of staghorn colonies necessary to meet the conservation potential of the permanently affected area is at the low end of the range of staghorn coral colonies proposed in the mitigation plan (i.e., 35,000-50,000). We believe that despite the loss of 23.62 acres of habitat the proposed action will have beneficial effects on designated critical habitat, by accelerating the provision of its intended conservations functions for staghorn coral; the conservation potential of the critical habitat areas to be occupied by the outplanted colonies will be realized on a much shorter time scale than would be possible naturally due to the currently low population densities of staghorn within this portion of designated critical habitat.

Above we calculated the maximum reproductive potential of the adversely affected portion of critical habitat as supporting up to 31,878 of 20-cm-diameter colonies of staghorn coral at the densities and coverages identified by the recovery team. Thus, this portion of critical habitat would realize its full potential to support recovery if it were colonized by 31,878 colonies of staghorn coral. As noted above, we do not believe that this portion of critical habitat would reach that goal during the lifetime of this project, if ever, given the current depressed abundance of staghorn coral that could provide recruits to colonize the area, and the physical barriers to colonization resulting from the existence of the harbor. The proposed action also includes the propagation and outplanting of 35,000 to 50,000 20-cm staghorn corals as part of the USACE's mitigation plan. These colonies will be outplanted over a 7-year period, thus contributing to the recovery of the species within this portion of the species' range over a very short time frame. The propagation and outplanting of staghorn coral will exceed the reproductive potential of the portion of critical habitat adversely affected. Further, the final blended mitigation plan will require that the outplanting be conducted in densities and genotypic composition to maximize the sexual reproductive potential. Currently, the species' low population size and patchy distribution is impeding the chances of successful sexual reproduction. The outplanting will increase the sexual reproductive potential within this portion of critical habitat as compared to status quo. Therefore, the project as a whole will not impede the recovery of the listed corals in the action area or range-wide despite the loss of 23.62 acres of critical habitat within the action area. Rather, it may even increase the likelihood of recovery of the species. As such, the proposed project would not destroy or adversely modify the designated critical habitat for listed corals.

In the event that the USACE selects a contractor who will anchor outside of the channel we have determined that there will be an additional 19.31 acres of permanent adverse impacts to critical habitat from anchor and cable drag. These impacts are considered *potential* impacts at this time, because they may or may not occur depending on the contractor selected. Therefore, they were not included in the total calculations above for the blended mitigation plan requirements. Should an additional impact of up to 19.31 acres of critical habitat result from anchor placement and cable drag, additional reef enhancement will be required via coral propagation and outplanting. An appropriate amount of staghorn corals will be included to achieve the mitigation requirements and conservation of the species. The USACE will be required to ouplant staghorn corals of the size and density described above in order to realize the full conservation potential of the additional 19.31 acres of critical habitat that would be permanently lost.

10 Conclusion

Using the best available data, we analyzed the effects of the proposed action in the context of the status of the species, the environmental baseline, and cumulative effects, and determined that the proposed action is not likely to jeopardize the continued existence of staghorn coral, any of the 6 corals proposed for listing, or Johnson's seagrass. These analyses focused on the impacts to, and population responses of, these species. Because the proposed action will not reduce the likelihood of survival and recovery of corals proposed for listing or Johnson's seagrass, it is our opinion that the proposed action is also not likely to jeopardize the continued existence of these species.

After reviewing the current status of staghorn coral critical habitat, the environmental baseline, the effects of the proposed actions, and the cumulative effects, it is our opinion that the expansion of Port Everglades will not impede the critical habitat's ability to support the conservation of staghorn (or elkhorn) corals and therefore will not destroy or adversely modify the critical habitat.

11 Incidental Take Statement

Section 9 of the ESA and federal regulation pursuant to Section 4(d) of the ESA prohibit take of endangered and threatened species, respectively, without special exemption. *Take* is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. *Incidental take* is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

NMFS must estimate the extent of take expected to occur from implementation of the proposed action to frame the limits of the take exemption provided in the Incidental Take Statement. These limits set thresholds that, if exceeded, would be the basis for reinitiating consultation. The following section describes the extent of take that NMFS anticipates will occur as a result of implementing the proposed action. If actual take exceeds an amount (or geographic or temporal extent) specified here, the exemption from the prohibition on take will be invalid for the excess amount, and re-initiation of consultation is required.

The prohibitions against taking the species found in Section 9 of the Act do not apply until the species is listed. However, NMFS advises the USACE to consider implementing the following reasonable and prudent measures. If the conference consultation on species proposed to be listed in opinion is adopted as a biological opinion following final listing, these measures, with their implementing terms and conditions, will be nondiscretionary, and must be undertaken by the USACE so that they become binding conditions of any grant, permit, or contract issued, as appropriate, for the exemption in Section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by this incidental take statement. If the USACE (1) fails to assume and implement the terms and conditions or (2) fails to require the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USACE must report the progress of the action and its impact on the species to NMFS as specified in the Incidental Take Statement (50 CFR §402.14(i)(3)).

11.1 Anticipated Amount of Take for Sea Turtles

Based on historical distribution data and hopper dredge observer take reports documenting previous hopper dredge takes of loggerhead and green sea turtles near the action area, we estimate that these 2 species may occur in the action area and may be taken by the hopper dredging operations of this project, by crushing and/or entrainment in suction dragheads. NMFS anticipates incidental take will consist of a total of 2 sea turtles (1 green and 1 loggerhead, or 2 greens, or 2 loggerheads) killed during hopper dredging at Port Everglades. Based on previous experience, we believe only 1 of these takes will be entrained, detected, and/or documented by onboard protected species observers. Therefore, we believe that there will be 1 *observed* take of either a green or a loggerhead.

Effect of the Take
NMFS has determined the anticipated level of incidental take specified in Section 11.1 is not likely to jeopardize the continued existence of loggerhead (NWA DPS), or green sea turtles.

11.2. Extent of Anticipated Take – Staghorn Coral
NMFS anticipates that the proposed action will result in take of this species in the form of collection. Coral nurseries will be established or augmented to support propagation of staghorn coral. Up to 250 colonies of staghorn corals are likely to be collected from the wild to supplement corals already established in nursery. Approximately 2,500 coral fragments of opportunity may also be collected. "Corals of opportunity" are the preferred source of colonies to populate coral nurseries, because they would have otherwise likely died without being collected and brought into the nursery. Sometimes, however, it is necessary to collect fragments from the wild to supplement the nursery population.

The protective regulations pursuant to ESA section 4(d) for staghorn provides for certain exceptions to the ESA section 9 prohibitions scientific research and species enhancement, and restoration carried out by authorized personnel (73 FR 64264; October 29, 2008). Thus, the take that may result from this project's propagation and outplanting of staghorn corals is not prohibited, as long as the actions are carried out pursuant to: (1) the exceptions in the 4(d) rule and (2) the Biological Opinion on the issuance of the rule. Because all activities related to coral propagation (i.e., wild collection, nursery establishment and operation, and outplanting) in Broward County require a State of Florida Special Activity License (SAL), the USACE will be required to hold a valid permit (SAL) and they will ne incompliance with the 4(d) rule. Thus, the take will not be prohibited and no incidental take statement is required. However, see the discussion below regarding consequences of the potential reclassification of this species to endangered status.

11.3 Extent of Anticipated Take – Proposed Corals Including Staghorn Listed as Endangered
As previously stated, NMFS has proposed to reclassify staghorn coral from threatened to endangered and proposed to list 6 additional coral species that occur within the action area. Should that proposal become final (decision due June 2014), the aforementioned 4(d) rule for staghorn corals will be void because there are no exceptions to the take prohibitions allowed for endangered corals. Therefore, the take that will result from the propagation activities will need authorization. Further, 6 coral species proposed for listing will be either lethally taken or relocated from the action area. Therefore, the take that would result from these activities would also have to be authorized.

In additional to take being authorized through biological opinions, NMFS may authorize take through ESA Section 10. Take that results from scientific research or enhancement activities may be authorized by an ESA Section 10(a)(1)(A) permit. Because there are multiple staghorn coral nurseries currently operational, the NOAA Restoration Center has submitted an application for an ESA Section 10(a)(1)(A) permit for propagation of the proposed endangered corals, in anticipation and preparation for the potential that they may be listed as endangered. This permit application covers activities conducted by the Restoration Center and its partners. It is anticipated that one of these entities would carry out the coral propagation activities proposed in the Port Everglades expansion; thus, should they receive their ESA Section 10 permit, the take that would result from this project would be authorized. Should that permit not be issued by the time the propagation portion of this project commences, the USACE will need to reinitiate consultation to request authorization for the take.

Since the USACE has requested conference consultation on the proposed species, at the proper time they must request that this Conference Opinion be confirmed as NMFS's Biological Opinion should the species be listed/reclassified. At that time, the USACE will also request take authorization for the corals that are ultimately listed as endangered that are proposed to be lethally taken and/or relocated from the action area. Based on our analyses in Section 6.5, we anticipate the following take of the proposed corals:

Table 8. Estimated Maximum Amount of Take of Proposed Coral Species From the Port Everglades Expansion Project

Proposed Coral Species	Mortality (Middle and Outer Reef ≤57ft 15.55 ac)	Relocation Survival (Middle and Outer Reef 15.55 ac)	Relocation Mortality (Middle and Outer Reef 15.55 ac)	Mortality (Middle and Outer Reef >57ft 6.11 ac)	Mortality (Channel Bottom and Walls 133 ac)	Mortality (Indirect Impact Area 1.96 acres)	Mortality Total
Lamarck's sheet	0	35	6	16	352	5	379
Elliptical star	1522	105	19	646	14,071	207	16465
Lobed star	1121	773	657	792	17,238	254	20062
Mountainous star	36	25	21	29	24	517	627
Knobby star	36	25	21	29	24	517	627
Rough cactus	82	35	6	48	1,055	16	1207

Effect of the Take
NMFS has determined the anticipated take specified in Section 11.2 is not likely to jeopardize the continued existence of staghorn coral if the project is developed as proposed. NMFS also has determined the anticipated take specified in Section 11.3 is not likely to jeopardize the continued existence of any of the proposed corals if the project is developed as proposed.

12 Reasonable and Prudent Measures (RPMs)

Section 7(b)(4) of the ESA requires NMFS to issue a statement specifying the impact of any incidental take on listed species, which results from an agency action otherwise found to comply with Section 7(a)(2) of the ESA. It also states that the RPMs necessary to minimize the impacts of take and the terms and conditions to implement those measures must be provided and must be followed to minimize those impacts. Only incidental taking by the federal agency or applicant that complies with the specified terms and conditions is authorized.

The RPMs and terms and conditions are specified as required by 50 CFR 402.12 (i)(1)(ii) and (iv) to document the incidental take by the proposed action and to minimize the impact of that take on staghorn coral. These measures and terms and conditions are non-discretionary, and must be implemented by the USACE or the contractor in order for the protection of Section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by this ITS. If the USACE or the contractor fails to adhere to the terms and conditions of the ITS through enforceable terms, and/or fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of Section 7(o)(2) may lapse. To monitor the impact of the incidental take, the USACE or the contractor must report the progress of the action and its impact on the species to NMFS as specified in the ITS [50 CFR 402.12(i)(3)].

NMFS has determined that the following RPMs are necessary and appropriate to minimize impacts of the incidental take of staghorn coral colonies and proposed coral species during the proposed action. The following RPMs and associated terms and conditions are established to implement these measures, and to document incidental takes. Only incidental takes that occur while these measures are in full implementation are authorized. These restrictions remain valid until reinitiation and conclusion of any subsequent Section 7 consultation.

1. Pre-construction survey. The USACE will conduct a pre-construction survey to document all listed and proposed species prior to construction.

2. The USACE must ensure that all colonies of coral species proposed to be listed that are over 10 centimeters are relocated from the middle and outer reefs prior to beginning construction. The USACE is also authorized to relocate smaller colonies (4 cm and greater). (Please note: the requirement to relocate corals of 10 cm or greater is based on specific details associated with this project and may not to be used as the standard for future biological opinions. NMFS recommends that the USACE relocate all proposed species greater than 4 cm.)

3. Blended Coral Mitigation plan. The USACE must refine and implement the blended mitigation plan discussed throughout this opinion.

4. Environmental monitoring plan. USACE must conduct environmental monitoring to assess whether environmental impacts of the project exceed thresholds identified in the DEIS.

The USACE must provide NMFS with all data collected during monitoring events conducted, as well as any monitoring reports generated following the completion of the proposed project. The monitoring programs shall include reporting requirements to ensure NMFS, USACE, and other relevant agencies are aware of corrective actions being taken when thresholds are exceeded, as well as ensure NMFS receives data related to the condition of listed corals in the area due to the importance of these listed species.

13 Terms and Conditions

In order to be exempt from liability for take prohibited by Section 9 of the ESA, USACE must comply with the following terms and conditions, which implement the RPMs described above. These terms and conditions are nondiscretionary.

1. USACE must record the location and size of all listed and proposed corals during the pre-construction surveys and provide this info to NMFS. (RPM 1)

2. Relocation of proposed coral species: Since transplantation can be stressful on corals and the natural environment is variable, we believe the best way to minimize stress and ensure the survival of all transplanted colonies is to follow the established protocols (see Appendix B). Qualified individuals following the protocols in Appendix B must conduct transplantation. The USACE must ensure that all transplanted colonies are relocated to suitable habitat near their original location, but no closer than 400 ft from the edge of the channel. For the purposes of this opinion, suitable habitat is considered: similar depth as origin (+/- 5ft), uncolonized hard substrate, appropriate water quality (based on water quality data and local knowledge), and minimal chances of other disturbances (boat groundings, damage caused by curious divers/fisherman). (RPM 2)

3. USACE must record the original location of each transplanted colony, as well as the location of each colony after transplantation. (RPM 2).

4. The detailed blended coral mitigation plan will continue to be refined and implemented in coordination with NMFS. The plan includes a comprehensive monitoring plan for all relocated and outplanted corals. USACE will submit a final, detailed mitigation plan to NMFS prior to construction. USACE will report progress in implementing and monitoring the mitigation plan, as specified in the final mitigation plan (RPM 3).

5. USACE shall continue to work with the established interagency team including USACE, NMFS, EPA, FDEP, and FWC to refine the environmental monitoring plan and to evaluate its effectiveness during implementation. USACE shall submit the final refined environmental monitoring plan to NMFS prior to construction. (RPM 4).

6. The monitoring methods employed shall be capable of detecting sedimentation and turbidity and physical impacts in coral reef and hardbottom habitat within 150 meters of the dredging areas, and detecting whether impacts are likely to exceed adverse impacts considered in this Opinion in a timely manner allowing for adaptive management, during all phases of construction. USACE shall share monitoring results with the interagency team (RPM 4).

7. In the event that monitoring of coral reef and hardbottom habitat within the 150 meter zone indicates that listed coral species are likely to be adversely impacted by dredging-related turbidity, sedimentation, or physical impacts in a manner or to a degree that would exceed the adverse impacts considered in this Opinion, USACE shall implement an adaptive management plan to avoid or minimize the impacts, which may include additional transplanting and monitoring of corals and hardbottom organisms. In developing the adaptive management plan, USACE shall consult with the interagency team and consider recommendations from the team. The USACE's selected adaptive management plan shall be provided to the interagency team before the time the adverse impacts considered in this opinion are expected to be exceeded. A goal of the adaptive management plan will be to avoid the need for reinitiation of consultation on this Opinion, but additional coordination may be required with NMFS to, for example, provide authorization for additional transplanting and relocation. (RPM 4).

8. USACE must ensure that all appropriate natural resource permits are obtained prior to relocation, propagation, and outplanting of corals. (RPMs 2, 3, and 4)

14 Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

NMFS believes the following conservation recommendations further the conservation of listed and proposed coral species. NMFS strongly recommends that these measures be considered and implemented, and requests to be notified of their implementation.

1. NMFS recommends that in addition to the proposed sharing of monitoring and reporting data, the USACE provide NMFS's Southeast Region Protected Resource Division (PRD), with the collected data submitted for all projects permitted concerning listed and proposed coral species.

2. NMFS continues to recommend that the USACE relocated all proposed and listed coral species 4 cm and greater. This is consistent with the best available science and the NMFS Habitat Office's conservation recommendations.

3. NMFS recommends that the USACE provide the location and size of all proposed and listed corals to all persons who hold the proper permits and who may be interested in rescuing those corals for use in research or educational activities.

4. NMFS strongly recommends that the USACE, in consultation with PRD, utilize its authority to carry out programs for the conservation of listed and proposed corals. Pursuant to ESA Section 7(a)(1), the USACE should develop a program to donate a

fragment of each acroporid colony directly impacted by all authorized or permitted activities to an appropriate coral nursery.

5. NMFS recommends that USACE prepare and use a report of all current and proposed USACE projects in the range of Johnson's seagrass to assess impacts on the species from these projects, to assess cumulative impacts, and to assist in early consultation that will avoid and/or minimize impacts to Johnson's seagrass and its critical habitat. Information in this report should include location and scope of each project and identify the federal lead agency for each project.

6. NMFS recommends that the USACE conduct and support research to assess trends in the distribution and abundance of Johnson's seagrass. USACE should contribute data collected to the Florida Fish and Wildlife Conservation Commission's Florida Wildlife Research Institute to support ongoing GIS mapping of Johnson's and other seagrass distribution.

7. NMFS recommends that the USACE, in coordination with seagrass researchers and industry, support ongoing research on light requirements and transplanting techniques to preserve and restore Johnson's seagrass, and on collection of plants for genetics research, tissue culture, and tissue banking.

8. NMFS recommends that the USACE prepare an assessment of the effects of other actions under its purview on Johnson's seagrass for consideration in future consultations.

9. NMFS recommends that the USACE promote the use of the October 2002, *Key for Construction Conditions for Docks or other Minor Structures Constructed in or over Johnson's Seagrass* as the standard construction methodology for proposed docks located in the range of Johnson's seagrass.

10. NMFS recommends that the USACE review and implement the recommendations in the July 2008 report, *The Effects of Docks on Seagrasses, With Particular Emphasis on the Threatened Seagrass, Halophila johnsonii* (Landry et al. 2008).

11. NMFS recommends that the USACE review and implement the Conclusions and Recommendations in the October 2008 report, *Evaluation of Regulatory Guidelines to Minimize Impacts to Seagrasses from Single-Family Residential Dock Structures in Florida and Puerto Rico* (Shafer et al. 2008).

In order to keep NMFS informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

15 Reinitiation of Consultation

As provided in 50 CFR Section 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if (1) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered, (2) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion, or (3) a new species is listed or critical habitat designated that may be affected by the identified action. In addition, if the USACE chooses a contractor or dredging methodology which may result in impacts to listed species or critical habitat above that which is considered in this Opinion, in particular, the impacts to critical habitat from anchoring discussed in section 6.3 above, reinitiation will be required.

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APPENDIX A

Background

Vessel Strike Avoidance Measures and Injured or Dead Protected Species Reporting NOAA Fisheries Service, Southeast Region

NOAA Fisheries Service has determined that collisions with vessels can injure or kill protected species (e.g., endangered and threatened species, and marine mammals). The following standard measures are recommended to reduce the risk associated with vessel strikes or disturbance of these protected species. NOAA Fisheries Service should be contacted to identify any additional conservation and recovery issues of concern for protected species in your operating area.

Protected Species Identification Training
Vessel crews should use an Atlantic and Gulf of Mexico reference guide that helps identify the species of marine mammals and sea turtles that might be encountered in U.S. waters of the Atlantic Ocean, including the Caribbean and Gulf of Mexico. Additional training should be provided regarding information and resources available regarding federal laws and regulations for protected species, ship strike information, critical habitat, migratory routes and seasonal abundance, and recent sightings of protected species.

Vessel Strike Avoidance
The following measures must be taken in order to avoid causing injury or death to marine mammals and sea turtles:

1. Vessel operators and crews will maintain a vigilant watch for marine mammals and sea turtles to avoid striking sighted protected species.

2. When whales are sighted, maintain a distance of 100 yards or greater between the whale and the vessel.

3. When sea turtles or small cetaceans are sighted, attempt to maintain a distance of 50 yards or greater between the animal and the vessel whenever possible.

4. When small cetaceans are sighted while a vessel is underway (e.g., bow-riding), attempt to remain parallel to the animal's course. Avoid excessive speed or abrupt changes in direction until the cetacean has left the area.

5. Reduce vessel speed to 10 knots or less when mother/calf pairs, groups, or large assemblages of cetaceans are observed near an underway vessel, when safety permits. A single cetacean at the surface may indicate the presence of submerged animals in the vicinity; therefore, prudent precautionary measures should always be exercised. The vessel will attempt to route around the animals, maintaining a minimum distance of 100 yards whenever possible.

6. Whales may surface in unpredictable locations or approach slowly moving vessels. When an animal is sighted in the vessel's path or in close proximity to a moving vessel, reduce speed and shift the engine to neutral. Do not engage the engines until the animals are clear of the area.

Additional Requirements for the North Atlantic Right Whale

1. If a sighted whale is believed to be a North Atlantic right whale, federal regulation requires a minimum distance of 500 yards be maintained from the animal (50 CFR 224.103 (c)).

2. Vessels entering North Atlantic right whale critical habitat are required to report into the Mandatory Ship Reporting System.

3. Mariners should check with various communication media for general information regarding avoiding ship strikes and specific information regarding North Atlantic right whale sighting locations. These include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners.

Injured or Dead Protected Species Reporting

Vessel crews will report sightings of any injured or dead protected species immediately, regardless of whether the injury or death is caused by your vessel.

Report marine mammals to the Southeast U.S. Stranding Hotline: 305-862-2850
Report sea turtles to the Southeast Regional Office: 727-824-5312

If your vessel is responsible for the injury or death, the responsible parties will remain available to assist the respective salvage and stranding network as needed. In addition, if the injury or death was caused by a collision with your vessel, you must notify the Southeast Regional Office immediately of the strike by telephone at (727) 824-5312, or by fax at (727) 824-5309. The report should include the following information:

a. the time, date, and location (latitude/longitude) of the incident;

b. the name and type of the vessel involved;

c. the vessel's speed during the incident;

d. a description of the incident;

e. water depth;

f. environmental conditions (e.g., wind speed and direction, sea state, cloud cover, and visibility);

g. the species identification or description of the animal, if possible; and
h. the fate of the animal.

For additional information, please contact the Protected Resources Division at:

NOAA Fisheries Service
Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701

Tel: (727) 824-5312
Visit us on the web at http://sero.nmfs.noaa.gov

APPENDIX B

Transplantation Protocols for Port Everglades Expansion Project.

All relocation field activities, data collection, analysis and reporting will be supervised by a marine biologist (minimum academic requirement is M.S. degree in related field, or equivalent experience) with experience in coral transplantation and survival monitoring. The qualifications of any persons conducting transplantation work must be submitted to NMFS Protected Resources Division, for review.

The colonies will be collected carefully using a hammer and chisel. Upon collection, the colonies must be kept in bins and maintained in seawater at all times. During transportation to the transplant site, the corals must be covered. Transplantation should occur as soon as operationally feasible, and no more than 24 hours after the colony is removed from its original location. The collected colonies must be kept at the original depth until transplantation commences (i.e., cached on site).

The USACE must ensure that all transplanted colonies are re-located to suitable habitat near their original location. The colonies must be transplanted no closer than 400 feet (ft) from the project area (550 ft from the edge of channel) in an area of suitable habitat/substrate resembling that of the colonies original location as soon as operationally feasible. For the purposes of this opinion, suitable habitat is considered: similar depth as origin (+/- 5 ft); means consolidated hardbottom (to include the artificial boulder reef site) or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover occurring in water depths from the mean high water (MHW) line to 30 meters (98 ft); appropriate water quality (based on water quality data and local knowledge), and minimal chances of other disturbances (boat groundings, damage caused by curious divers/fisherman). All efforts should be made to transplant the fragment to the same depth from which it was removed (i.e., +/- 5 ft).

The material used to attach the colonies to suitable substrate must be Portland cement. Before applying the Portland cement to the substrate, it must be cleaned of any sediment or algae. The Portland cement should then be taken out of the dry lock bag and pressed against the clean substrate. The transplanted colonies must then be pressed gently into the Portland cement with proper care. Transplanted colonies must be no closer than 0.75 meters from one another.

To assist in monitoring efforts, a plastic identification tag must be attached adjacent to each transplanted colony. Finally, the collected location, length, width, depth and orientation of each colony to be transplanted will be recorded. The transplanted location and depth of each colony, as well as the species and identification number, will be recorded.

APPENDIX C

Calculations for Port Everglades mitigation

Area of impact = 21.66 acres
From the draft *Acropora* Recovery Plan, density of 1 colony (≥0.5 m diameter) per m^2 in 5% of consolidated habitat 5-20 m depth.
5% of 21.66 acres = 1.083 acres = 4,382.7 m^2
<u>Area of a square</u>: Colony 0.5*0.5 m = 0.25 m^2 coral occupancy per m^2 of hardbottom
Assume outplanted colonies will be 0.2 m diameter: 0.2*0.2 m=0.04 m^2 in area
0.25m^2/0.04m^2=6.25 colonies needed per m^2 hardbottom
4,382.7 m^2 * 6.25 colonies ≈ **27,392 colonies needed**
<u>Area of a circle</u>: colony 0.5 m diameter = 0.2 m^2 coral occupancy per m^2 of hardbottom
Assume outplanted colonies will be 0.2 m diameter: 0.1^2 * 3.14 = 0.03 m^2 in area
0.2 m^2/0.03 m^2=6.67 colonies needed per m^2 hardbottom
4,382.7 m^2 * 6.67 colonies ≈ **29,233 colonies needed**

Based on data from Gilliam (see table below)
Assume colony mortality of 44% per year
Assume partial mortality rate of 25% per year (75% tissue survival)
Assume colony growth rate of 8 cm per year (diameter)
Assume recruitment rate of 22% per year

Per m^2 hardbottom:
colonies: 6.25-2.75+1.4=4.9 colonies
coral tissue growth: 4.9 colonies* (0.28 m*0.28 m)=0.38 m^2
tissue survival: 0.75*0.38 m^2= 0.28 m^2

Conclusion: With the very rough estimates of recruitment, mortality, and growth rates, an estimated 27,392 to 29,233 colonies will need to be outplanted to maintain the density/coverage criteria from the Acropora Recovery Plan.

Notes for Port Everglades expansion mitigation

Brian Walker (Pers. Comm.) NSU/NCRI

Broward County	m^2	km^2	acres	hectares
Coral Reef and Colonized Hardbottom	44,689,106	44.68911	11,042.92	4,468.911
Known *A. cervicornis* area	155,000	0.155	38.30133	15.5

K. Wirt (Pers. Comm.) FL FWC/USF

Approximately 600 *A. cervicornis* sightings in Broward (see map)

(Vargas-Angel et al. 2003)

Thickets: 1,000 m^2 to ~8,000 m^2 in area

% cover: ~5-28%

Recruit (< 5 cm dia) density: 0-1 m^{-2}; mean 0.1 m^{-2}

Largest colony diameter: 1.8 m

Largest colony density: 3 m^{-2}

Mean cover affected by WBD: 1.8%

(Walker et al. 2012)

Thickets: ~10,400 m^2 and 22,500 m^2

(Hollarsmith et al. 2012)

Outplanted 1 yr old colonies 20-40 cm diameter

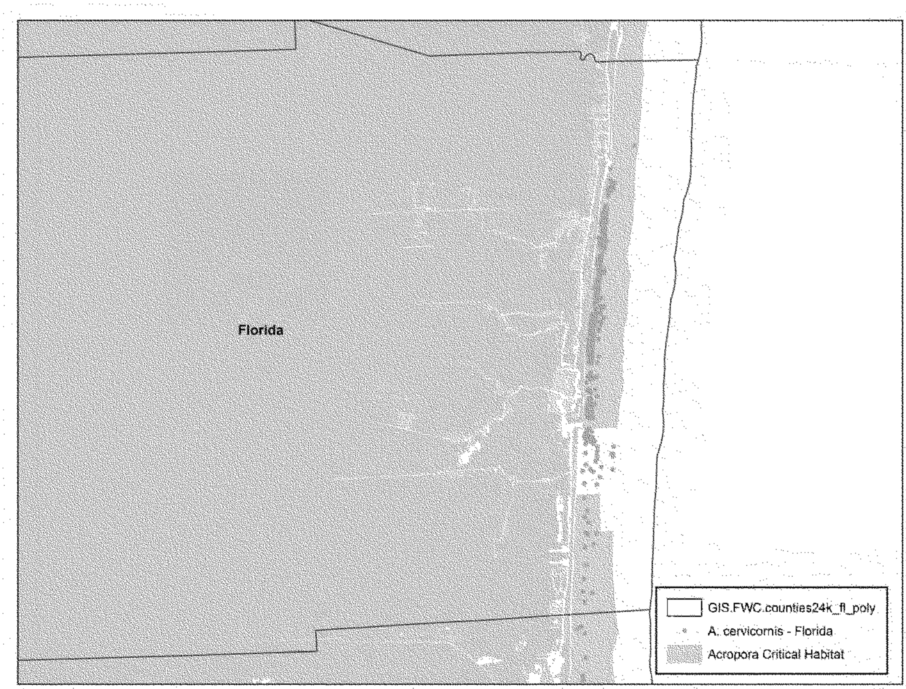
Data from D. Gilliam, NSU

Nova Southeastern University Oceanographic Center											
David S. Gilliam											
15-Nov-2013											
***Acropora cervicornis* data**											
Project	**Duration of Project**	**n_i**	**n_e**	**% Survival**	**Mean change in whole colony diameter (cm) ± SD**	**Mean % Live**					

Broward *Acropora* mapping project	2 yrs	63	33	52%	10.5 ± 22	71 ± 29					
2007 Nursery Donor Colonies	1.5 yrs	10	6	60%	8 ± 31	66 ± 39					
2010 Nursery Donor Colonies	2 yrs	20	11	55%	5.5 ± 22	87 ± 19					
Recruitment											
Site 1- Broward	Fall 2010	Winter 2011	Summer 2011	Fall 2011	Winter 2012	Summer 2012	Fall 2012	Winter 2013	Summer 2013	Fall 2013	
Colonies	271	392	548	405	599	681	390	412	419	501	
Fragments	514	364	410	526	462	249	506	394	315	403	
Site 2- Broward											
Colonies	122	125	163	159	201	233	147	202	202	203	
Fragments	111	48	87	235	266	108	190	129	98	139	
<u>Notes</u>											
Survivorship											
n_i= number of colonies at beginning of project											
n_e= number of colonies remaining at end of project monitoring											
Colonies were considered "dead" if they went missing. A majority of the colonies that we lost were due to colony dislodgement, this does not necessarily mean they are dead, but may have fragmented and attached elsewhere at the site.											
Growth											

Only whole colony size was measured for these projects. Change in colony size came from the change in final colony max diameter from the initial colony max diameter over the length of the project											
Recruitment											
Colonies and fragments are counted 3 times a year within permanent monitoring stations. These are not fate tracked but may give an indication of recruitment through asexual reproduction.											

Map from K. Wirt (FWC)



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

SEP 05 2012

Planning and Policy Division
Environmental Branch

Mr. David Bernhart
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
263 13th Ave South
St. Petersburg, Florida 33701

Dear Mr. Bernhart:

This letter and associated information package supplements the consultation requests provided to your office on March 25, 2002 and September 17, 2004 for the Port Everglades Feasibility Study.

The U.S. Army Corps of Engineers, Jacksonville District (Corps) is currently conducting a feasibility study to assess the Federal interest in cost sharing the recommended navigational improvements and their continued maintenance. This assessment includes evaluation of engineering, environmental and overall economic effect of the proposed project. The Feasibility Study was congressionally authorized by a resolution of the House Committee on Transportation dated May 9, 1996.

The Recommended Plan main elements include:

a. deepen and widen the Outer Entrance Channel (OEC) from an existing 45-foot project depth over a 500-foot channel width to 57 feet* by 800 feet and extend 2,200 feet seaward;
b. deepen the Inner Entrance Channel (IEC) from 42 feet to 50* feet;
c. deepen the Main Turning Basin (MTB) from 42 feet to 50* feet;
d. widen by approximately 300 feet the rectangular shoal region to the southeast of the MTB (Widener) and deepen to 50* feet;
e. widen the Southport Access Channel (SAC) in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 feet and relocate the United State Coast Guard (USCG) facility, easterly on USCG property;
f. shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition back to the existing Federal channel limits;
g. deepen the SAC from about berth 23 to the south end of berth 32 from 42 feet to 50* feet;

h. deepen the Turning Notch (TN), including the expanded portion from 42 feet to 50* feet with an additional 100-foot north-south widening parallel to the SAC channel on the eastern edge of the SAC over a length of about 1,845 feet and widen the western edge of the SAC for access to the TN from the existing Federal channel edge near the south end of berth 29 to a width of about 130 feet at the north edge of the TN;

(*All dredging depths have an additional two feet of potential dredging added to them for overdepth – one foot of required overdepth and one foot of allowable overdepth).

i. construct environmental mitigation for unavoidable, minimized impacts;

j. pre-treat rock substrates as necessary and take appropriate measures to safeguard protected species during that process;

k. dispose of dredged material not used for mitigation construction east of the Port at the Offshore Dredged Material Disposal Site (ODMDS), which is currently proposed for expansion by USEPA. If it is not expanded, the maximum amount of material that can be placed within the existing site will be deposited, and alternatives will be explored for the deposition of remaining material (NEPA coordination to that effect are currently underway).

Enclosed please find the Corps' Biological Assessment of the effects of the proposed project on listed species in the action area. Attached to this Biological assessment are the following:

a. A chronologic history of the consultation
b. September 17, 2004 Biological Assessment
c. March 25, 2002 Biological Assessment
d. August 28, 2008 – Meeting Notes from *Acropora* Survey Meeting held in St. Petersburg
e. March 26, 2008 – Letter from NMFS to Marie Burns regarding need for Acropora survey
f. October 18, 2006 – Letter from Marie Burns to David Bernhart regarding USACE effects determination for *Acropora*.
g. October 13, 2006 - Letter from NMFS to Marie Burns regarding USACE effects determination for *Acropora*.
h. August 18, 2006 – Letter from NMFS to Terri Jordan regarding USACE Reef Assessment Report.
i. Benthic Habitat Characterization for the South Florida Ocean Measurement Facility. Protected Stony Coral Assessment. Prepared by NOVA SE University. December 2011.
j. Port Everglades Feasibility Study *Acropora* Coral Survey Final Report. October 2010.
k. Benthic and Fish Community Assessment at Port Everglades Harbor Entrance Channel. December 2009.
l. Environmental Baseline Study and Impact Assessment for Port Everglades Harbor. Final Report. May 31, 2001
m. Seagrass Mapping and Assessment Port Everglades Harbor. Final Report. October 5, 2006
n. Seagrass Mapping and Assessment Port Everglades Harbor. Final Report. December, 2009

Although all of this material has been previously provided to your staff over the 10-year course of this consultation, due to staff changes, etc., per your request in addition to the *Acropora* specific information, we are providing a complete copy of all materials associated with the consultation in one.

We request continuation and completion of consultation under section 7 of the Endangered Species Act concerning the effects of the proposed action on listed-species under NMFS' jurisdiction and any designated critical habitat.

If you have any questions, please contact Ms. Terri Jordan-Sellers at 904-232-1817 or Terri.Jordan-Sellers@usace.army.mil.

Sincerely,

Jason J. Spinning
Chief, Coastal Section
Environmental Branch

Enclosure

CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT-PORT EVERGLADES NAVIGATION PROJECT

The Corps is supplementing the ongoing consultation under Section 7 of the Endangered Species Act (ESA) for the Port Everglades expansion project. Specifically this Biological Assessment (BA) addresses potential effects of the proposed harbor expansion project to the *Acropora sp.* corals and designated critical habitat (DCH) during project construction. The original consultation for this project was initiated by letter dated March 25, 2002 (logged into NMFS system as F/SER/2002/00626) and amended by letter dated September 17, 2004. That consultation assessed the effects of the proposed project on green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), Hawksbill sea turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), Johnson's seagrass (*Halophila johnsonii*), blue (*Balenoptera musculus*), humpback, (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balenoptera physalus*) and sperm (*Physeter macrocephalus*) whales and smalltooth sawfish (*Pristis pectinata*). A summary of each species is restated in this assessment with new information added where applicable and the reader referred to the original information included in the previous consultation documents.

This additional supplement is triggered by the listing of Acroporid corals as threatened and designation of critical habitat under the ESA, as required by 50 CFR 402.16(d). Per agreement with National Marine Fisheries Service (NMFS) during an April 28, 2008 meeting, the Corps and NMFS would move ahead with the consultation.

Consultation History

A detailed history of the consultation is included in the Consultation package, appendix 1 and is incorporated by reference. The Corps also incorporates the meeting notes from the April 23, 2008 meeting between NMFS-PRD leadership and CORPS staff and leadership concerning the path forward with regard to the consultation and the listing of *Acropora* species. The meeting notes are found in Appendix 4 of the consultation package. In 2010, CORPS was able to conduct *Acropora* surveys utilizing the new protocol for deep draft navigation harbors developed with NMFS in response to the April 2008 meeting.

Project Location

Port Everglades (Port), located in Broward County, is the seventh largest seaport on the Atlantic coast of the US and located on the southeast coast of Florida (Figure 1). It is located within the cities of Hollywood, Dania Beach, and Fort Lauderdale, with immediate access to the Atlantic Ocean. The entrance of the Port is approximately 27 nautical miles north of Miami Harbor, Florida and 301 nautical miles south of Jacksonville Harbor, Florida. The existing authorized Port Everglades Federal Navigation Project provides for an Outer Entrance Channel (OEC) that is 45 feet deep and 500 feet wide (Figure 2), an Inner Entrance Channel (IEC) that is 450 feet wide and 42 foot deep, a Main Turning Basin (MTB) that is 42 feet deep, a North Turning Basin (NTB) that is 31 feet deep, a South Turning Basin (STB) that is 31 to 36 feet deep, a Southport Access Channel (SAC) that is 390 to 400 feet wide and 42 feet deep, and a Turning Notch (TN) that is 42 feet deep.

Figure 1 - Location of Port Everglades Harbor

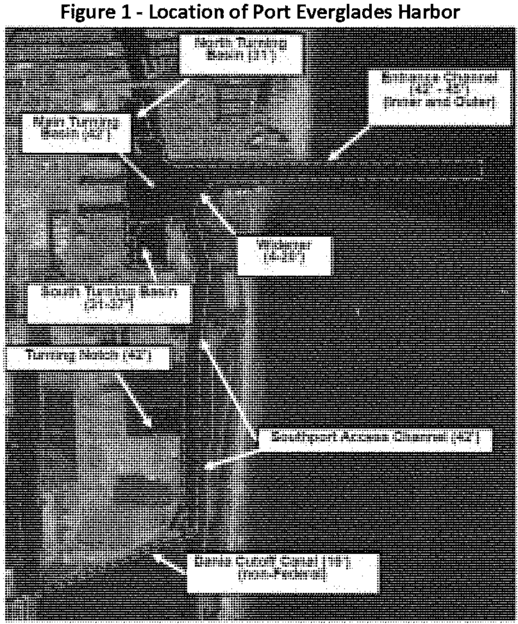


Figure 2 - Existing Project Components

Figure 3 shows Port-associated facilities and berths. To the east of the Port is a barrier island that contains a U.S. Navy (USN) facility, the Nova Southeastern University Oceanographic Center (NSUOC) , a U.S. Coast Guard (USCG) facility, and John U. Lloyd Beach State Park (JUL) and its adjacent beaches. South of the Dania Cutoff Canal (DCC) is the West Lake Park area. West of the Port is Federal Highway which is flanked by the Fort Lauderdale/Hollywood International Airport. North of the Port is a mixture of small craft waterways and commercial and residential development.

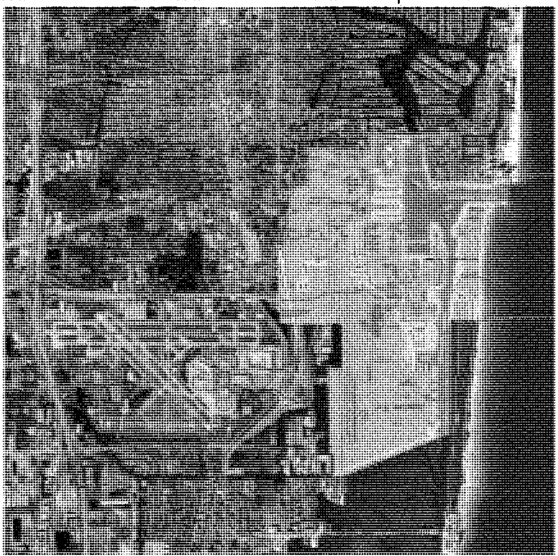


Figure 3 - Existing Port Infrastructure and Surrounding Properties

The port was originally dredged by private interests between 1927 and 1928. The first modifications to Port Everglades were authorized by Congress in 1930 and since then, several additional modifications to accommodate larger vessels have been congressionally authorized or federally permitted (1935, 1938, 1946, 1958, 1974, 1980 and 1989). Additionally, various berths and channels in Port Everglade have been maintenance dredged over the last 25 years (Table 1).

Table 1 - O&M Dredging History of Port Everglades

Year	Area Dredged	Dredge Company	Volume (CY)	Disposal Area
1971	S Turn Basin	Hendry Corp.		Present Berth 29 Area
1978	Slips 1,2,3	Ajax Co.	60,000	Present Berth 29 Area
1979	S Turn Basin	Merritt Dredging	120,000	Present Berth 29 Area
1980	Slips 1,3	Powell Bros.	40,000	Present Berth 29 Area
1991	Slip 1	Southport Dredging	9,782	Dockside-trucked off port
1994	Slip 3	Frenz Enterprises	7,000	Dockside-trucked off port
2000	Slips 1,2,3	Subaqueous Services	11,053	Southport-used as backfill
2004	slip 3	Shoreline Foundation	200	Dockside-use for rip rap
2005	Slip 3, Berth 21,22	Subaqueous Services	7,335	Southport-used as backfill
2005	North Turning Basin 7+60 to 18+67	Great Lakes Dock & Dredge	60,210	ODMDS
2005	Outer Entrance Channel	Great Lakes Dock & Dredge	547,000	John U Lloyd State Beach Park
2007	Berth 29	Subaqueous Services	8,070	Southport- used as backfill

Description of the Proposed Action

After twelve years of development, review, analysis and component minimization, the Tentatively Selected Plan (TSP) has been selected. The Project will require the removal of approximately five (5) million cubic yards of shallow sands and massive, hard rock. Features of the current TSP, (Figure 4), include;

a. extending the Outer Entrance Channel (OEC) 2,200 feet seaward with an 800-foot wide flare, and deepening the existing 500-foot wide OEC from 45 feet to 57 feet, plus one foot of required overdepth and one foot of allowable overdepth for a total of 59 feet;
b. deepening the Inner Entrance Channel (IEC) from 42 feet to 50 feet, plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet;
c. deepening the Main Turning Basin (MTB) from 42 feet to 50 feet plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet;
d. widening the rectangular shoal region southeast of the MTB (Widener) by approximately 300 feet and deepening it to 50 feet plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet;
e. widening the Southport Access Channel (SAC) in the proximity of berths 23 to 26 (the knuckle) by approximately 250 feet and relocating the USCG facility, easterly on USCG property;

f. shifting the existing 400-foot wide SAC approximately 65 feet to the east near berth 26 to the south end of berth 29 to transition from the knuckle area widening to the existing Federal channel limits;
g. deepening the SAC from approximately berth 23 to the south end of berth 32 from 42 feet to 50 feet plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet;
h. deepening the Turning Notch (TN), including the Port Authority planned expansion (if completed by the port), from 42 feet to 50 feet plus one foot of required overdepth and one foot of allowable overdepth for a total of 52 feet, with nearby widening including (1) widening the eastern edge of the SAC 100 feet along a 1,845 stretch parallel to the SAC and (2) widening the western edge of the SAC for access to the TN from the existing Federal channel near the south end of berth 29 to a width of about 130 feet at the north edge of the TN, and
i. Deepening the port's berthing areas adjacent to the federal channel and basins.

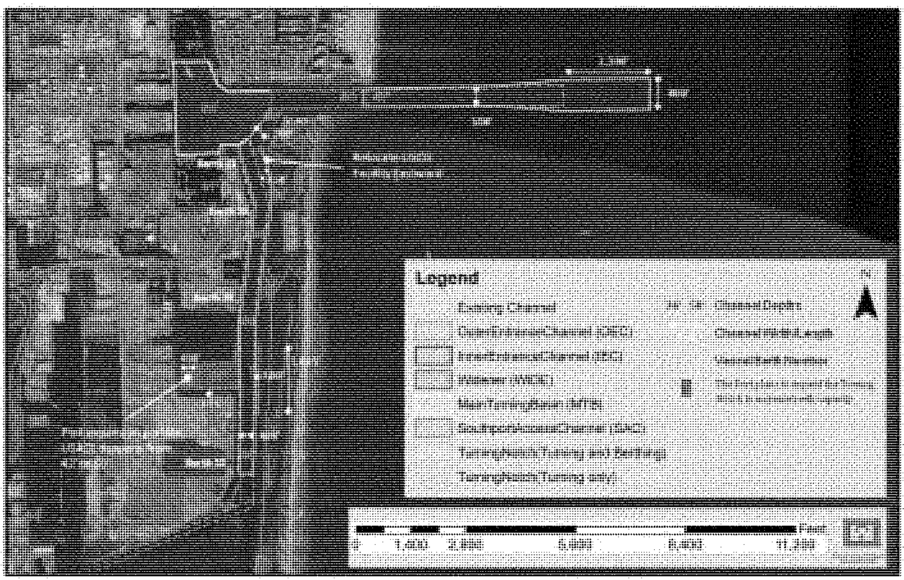


Figure 4 - Tentatively Selected Plan

Overview of Dredging and Rock Pre-Treatment Methods

Based on geotechnical boring data from the entrance channel, sand, silt, clay, and rock of varying hardness are expected to be encountered in the entrance channel. Sand, silt, clay, soft rock, rock fragments, and loose rock will be removed via traditional dredging methods. Where hard rock is encountered, the Corps anticipates that contractors will utilize other methods, including confined blasting or large cutterhead dredge equipment to pre-treat the rock prior to removal. Blasting will be implemented only in those areas where standard construction methods, including large cutterhead dredges, are anticipated to be unsuccessful. Dredged material will be deposited at two locations. Some rock and coarse materials will be transported by barge and may be placed at an artificial reef site as potential compensatory mitigation for unavoidable and minimized impacts to reef/hardbottom communities. The balance of rock and coarse materials that cannot be beneficially utilized for mitigation will be transported to the Offshore Dredged Materials Disposal Site (ODMDS).

Five separate dredging and pre-treatment methodologies may be utilized in the deepening and expansion of the port's channels and basins. Each one will be evaluated separately since they rely on differing equipment, and thus different effects may occur. Construction methodology of the project will be determined by the contractor selected by the Corps during the bid process. However, certain assumptions can be made regarding various techniques that may be needed to complete construction; those assumptions are the basis for this consultation. If an alternative construction methodology, not included in this consultation is proposed by the selected contractor, that result in effects to the species under NMFS' jurisdiction that are different than those analyzed here, the Corps will reinitiate consultation.

Dredging equipment is classified as either hydraulic or mechanical based upon the means of transporting the dredged material from the channel bottom. Hydraulic dredges use water to pump the dredged material as slurry to the surface and mechanical dredges use some form of bucket to excavate and raise the material from the channel bottom. The most common hydraulic dredges include cutter-suction and hopper dredges and the most common mechanical dredges include clamshells and backhoes (also referred to as marine excavator or dipper dredges). In addition to clamshell and backhoe dredges, mechanical dredges also include bucket ladder dredges, however, US law requires that dredges working on federally funded projects have US built hulls and no large scale bucket ladder dredges capable of conducting rock dredging are currently available for US work. Various project elements influence the selection of the dredge type and size. These factors include the type of material (rock, clay, sand, silt, or combination); the water depth; the dredge cut thickness, length, and width; the sea or wave conditions, vessel traffic conditions, environmental restrictions, other operating restrictions; and the required completion time. All of these factors impact dredge production and as a result costs. Multiple dredges of the same or different types may be used on projects where conditions vary between dredging locations or to expedite the work.

The following discussion of dredges and their associated impacts will be limited to potential dredging equipment suitable for the Port Everglades deepening project. The key project elements for this deepening project include:

- •Material is primarily rock, much of which is classified as hard to very hard and may require pretreatment (such as blasting) prior to dredging.
- •The widening areas include an overburden of silt, sand, and soft rock over the hard rock areas.
- •Significant environmental resources including reefs are located adjacent to project.
- •Project includes open water dredging in a channelized environment.
- •Project depth is -50 MLLW plus 7 feet of underkeel clearance + 1 foot required overdepth +1 foot allowable overdepth for a total dredge depth of 59 feet in the outer entrance channel and -50 MLLW + 1 foot required overdepth +1 foot allowable overdepth for a total dredge depth of 52 feet in the inner channels and basins.

Dredged material will most likely be excavated using either a hydraulic cutterhead dredge or mechanical excavator with some or all of the material pretreated using confined blasting or some other method to break the hard rock prior to dredging. If a mechanical dredge is used, the larger dredged material may be removed and segregated at the construction site for use in constructing the mitigation sites. Larger rock material will be placed on one barge/scow to be transported to an artificial reef site, while other materials would be placed on a separate barge/scow for placement in the offshore disposal site. In any event, disposal of all dredged material would be in the ODMDS and/or an artificial reef site. Any unconsolidated material in the channel (beach quality sand) that may have filled in the channel south of the south jetty, may be removed by a hopper dredge and placed in accordance with the Environmental Assessment for Operations and Maintenance Dredging completed with a Finding of No Significant Impact signed on April 28, 2005, that the Corps completed two ESA consultations for in 2004 and 2012, both resulting in concurrence with the Corps' determination that O&M dredging of Port Everglades was either already covered by the 1997 South Atlantic Regional Biological Opinion (NMFS, 2004) or a determination that placement of beach quality O&M material, "may affect, but is not likely to adversely affect" listed species under NMFs' purview. Additionally, NMFS concurred that the placement of beach quality O&M material was not likely to adversely modify designated critical habitat offshore of the dredged material placement area, John U Lloyd state park (NMFS, 2012).

The project scale limits potential equipment to large-scale hydraulic or mechanical dredges. Potential equipment must be able to reach 55 to 60 feet in depth, depending upon wave and tide conditions as well as excavate large material volume.

Hydraulic Dredges

Hydraulic dredges are characterized by their use of a pump to dredge sediment and transport slurry of dredged material and water to identified discharge areas. The ratio of water to sediment within the slurry mixture is controlled to maximize efficiency. The main types of hydraulic dredges are pipeline and hopper dredges.

Pipeline Dredges - Cutterhead Suction Dredge
Pipeline dredges are designed to handle a wide range of materials including clay, hardpan, silts, sands, gravel, and some types of rock formations without blasting. They are used for new work and maintenance in projects where suitable placement/disposal areas are available and operate in an almost continuous dredging cycle resulting in maximum production, economy, and efficiency. Limitations of pipeline dredges include relative lack of mobility, long mobilization and demobilization, inability to work in high wave action and currents, and are impractical in high traffic areas.

Pipeline dredges are rarely self-propelled and; therefore, must be transported to and from the dredge site. Pipeline dredge size is based on the inside diameter of the discharge pipe which commonly ranges from 6" to 48." They require an extensive array of support equipment including pipeline (floating, shore, and submerged), boats (crew, work, survey), barges, and pipe handling equipment. Most pipeline dredges have a cutterhead on the suction end. A cutterhead is a mechanical device that has rotating teeth to break up or loosen the bottom material so that it can be sucked through a pipe to the dredge (Figure 5).

Large cutter-suction dredges, or cutterhead dredges, are mounted on barges. The key parts of a cutter-suction dredge include:

- The cutter-suction head that resembles an egg beater with teeth that break up the dredged material as it rotates. The broken material is hydraulically moved into the suction pipe for transport.
- The cutter suction head is located at the end of a ladder structure that raises and lowers it to and from the bottom surface.
- The discharge pipeline connects the cutter suction dredge to the disposal location. The dredged material is hydraulically pumped from the bottom, through the dredge, and through the discharge pipeline to the disposal location. This is generally an upland site, but can be a scow for transport to a remote location, ODMDS or an in-water site.
- Dredge pumps are located on the barge with additional pump(s) often located on the ladder, especially for deep water dredging projects such as Port Everglades. Booster pumps can also be added along the discharge pipeline to move the material greater distances.

Depending upon their design, cutterhead dredges can be used to remove blasted or unblasted rock and unconsolidated material. During the dredging operation a cutterhead suction dredge is held in position by two spuds at the stern of the dredge, only one of which can be on the bottom while the dredge swings. There are two swing anchors some distance from either side of the dredge, which are connected by wire rope to the swing wenches. The dredge swings to port and starboard alternately, passing the cutter through the bottom material until the proper depth is achieved. The dredge advances by "walking" itself forward on the spuds. This is accomplished by swinging the dredge to the port, using the port spud and appropriate distance, then the starboard spud is dropped and the port spud is raised. The dredge is then swung an equal distance to the starboard and the port spud is dropped and the starboard spud is raised.

A large cutterhead dredge could be used for the entire Port Everglades deepening project. Some pretreatment may be required for portions of the rock prior to dredging. Disposal options include transport by barges to the ODMDS or use as mitigation site creation material. When the material will be taken to the ODMDS, the material maybe loaded into scows using a barge known as a Spider barge. This barge allows for one scow to be loaded and a second to begin loading immediately after the first is complete, ensuring more efficient dredging due to lessened down time waiting for scows to return from the ODMDS. A spider barge was used at Miami Harbor during the 2005-2006 in a similar dredging event (Figure 6).

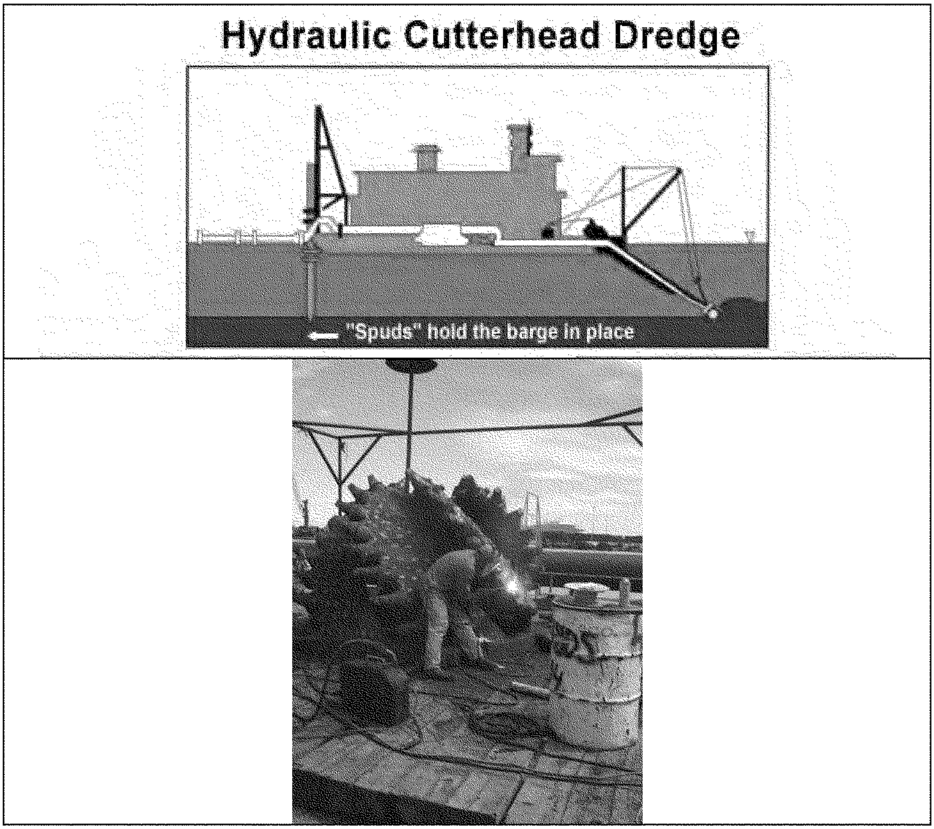


Figure 5 - Cutterhead pipeline dredge schematic and representative close-up photographs. (Video of cutterhead dredge: http://el.erdc.usace.army.mil/dots/doer/anima/cutterside.avi)

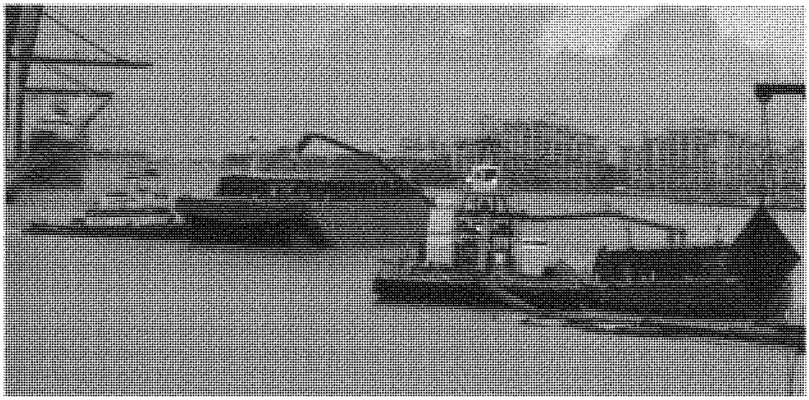


Figure 6 - A spider barge loading material into two scows from the cutterhead dredge, Texas, during Miami Harbor Phase II 2005-2006.

Hopper Dredge.

The hopper dredge, or trailing suction dredge, is a self-propelled ocean-going vessel with a section of the hull compartmented into one or more sediment containment chambers called hoppers. Fitted with powerful pumps, the dredges suck sediment from the channel bottom through long intake pipes, called drag arms, and store it in the hopper(s). Normal hopper dredge configuration has two dragarms, one on each side of the vessel. A dragarm is a pipe suspended over the side of the vessel with a suction opening called a draghead for contact with the bottom (Figure 7). Depending on the hopper dredge, a slurry of water and sediment is generated from the plowing of the draghead "teeth," the use of high pressure water jets, and the suction velocity of the pumps. The dredged slurry is distributed within the vessels hopper allowing for solids to settle out and the water portion of the slurry to be discharged from the vessel during operations through its overflow system. When the hopper attains a full load, dredging stops, the dragarms are lifted off the bottom and the ship travels to an in-water disposal site, where the dredged material is discharged through the bottom of the ship by splitting the hull, or opening doors located in the bottom of each hopper. Some hopper dredges are capable of pumping the material back out of the vessel and through a series of shore-pipe to a designated placement/disposal location.

Hopper dredges are well suited to dredging heavy sands. They can maintain operations safely, effectively, and economically in relatively rough seas and because they are mobile, they can be used in high-traffic areas. They are often used at ocean entrances and offshore, but cannot be used in confined or shallow areas. Hopper dredges also have several limitations. Considering their normal operating conditions, hopper dredges cannot dredge continuously. The precision of hopper dredging is less than other types of dredges; therefore, they have difficulty dredging steep side banks and cannot effectively dredge around structures.

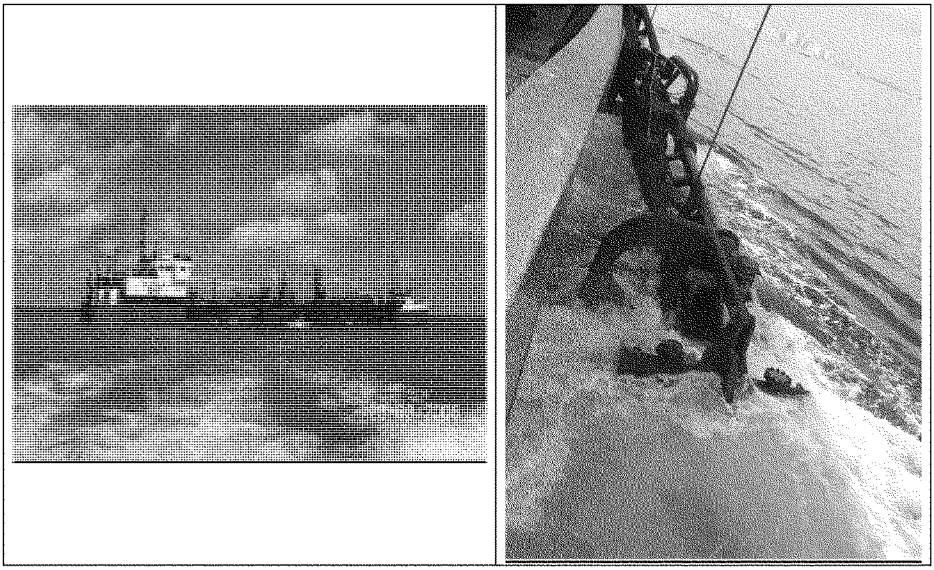


Figure 7 - Hopper dredge and dragarm being lowered into the water (Video of hopper dredge - http://el.erdc.usace.army.mil/dots/doer/anima/turtle.avi)

The Corps will incorporate the Terms and Conditions in NMFS' 1997 "Regional Biological Opinion (RBO) on Hopper Dredging along the South Atlantic Coast" into the project specifications, or any subsequent Regional Biological Opinion issued for hopper dredging. Although the SARBO does not include new harbor deepening projects in the project description, the Corps expects that that protective measures of the SARBO are sufficient to protect sea turtles in Port Everglades where the Corps has dredged on previous occasions with a hopper dredge without incidental take of sea turtles (2005 O&M dredging; 2004-2005 Broward Shore Protection project). The 1997 RBO incorporates (by reference) NMFS' 1995 Biological Opinion on hopper dredging of channels and beach nourishment activities in the southeastern US from North Carolina through Florida East Coast. The Corps' specifications will require their contractor(s) to follow the Terms and Conditions in the 1997 and 1995 Biological Opinions mentioned above, with the exception of the conditions related to the southeast United States' North Atlantic Right Whale calving area, because the proposed project is not located in or near the calving area. The Corps will also incorporate the protective measures of NMFS' March 23, 2006, Sea Turtle and Smalltooth Sawfish Construction Conditions into the project plans and specifications.

Mechanical Dredges

Mechanical dredges are characterized by the use of some form of bucket to excavate and raise the bottom material (Figure 8). They remove material by scooping it from the bottom and then placing it onto a waiting barge/scow or directly into a placement/disposal area. Mechanical dredges work best in consolidated, or hard-packed, materials and can be used to clear rocks and debris. Dredging buckets have difficulty retaining loose, fine materials, which can be washed from the bucket as it is raised. Special buckets have been designed for controlling the flow of water and material from buckets and are used when dredging contaminated sediments. Mechanical dredges are rugged and can work in tightly confined areas. They are mounted on a large barge and are towed to the dredging site and secured in place by anchors or spuds. They are often used in harbors, around docks and piers, and in relatively protected channels, but are not suited for areas of high traffic or rough seas.

Backhoe dredges and clamshell dredges, named for the scooping buckets they employ, are the two most common types. For clamshell dredges, a bucket dredge begins the digging operation by dropping the bucket in an open position from a point above the sediment. The bucket falls through the water and penetrates into the bottom material. The sides of the bucket are then closed and material is sheared from the bottom and contained in the bucket compartment. The bucket is raised above the water surface, swung to a point over the barge, and then released into the barge by opening the sides of the bucket. Usually two or more disposal barges, called dump scows, are used in conjunction with the mechanical dredge. While one barge is being filled, another is being towed to the disposal site by a tug and emptied. If an upland disposal area is used, the material must be unloaded using mechanical or hydraulic equipment. Using numerous barges, work can proceed continuously, only interrupted by changing scows or moving the dredge. This makes mechanical dredges particularly well suited for dredging projects where the disposal site is many miles away.

The backhoe dredge is essentially a power shovel mounted on a barge. The backhoe digs toward the machine with the bucket penetrating from the top of the cut face. The operation cycle is similar to the clamshell dredge, as are the factors affecting production. Backhoe marine excavators have accurate positioning ability and are able to excavate firm or consolidated materials. However, they are susceptible to swells and have low to moderate production. Backhoe marine excavators could be used to excavate unconsolidated overburden, fractured rock, and possibly some unfractured rock. It should be noted that one of the largest backhoe marine excavators in the U.S. was unsuccessful in dredging rock within Miami Harbor in the early 1990s in some locations without a pretreatment fracturing technology, and the rock at Port Everglades is expected to be harder based on geotechnical analysis.

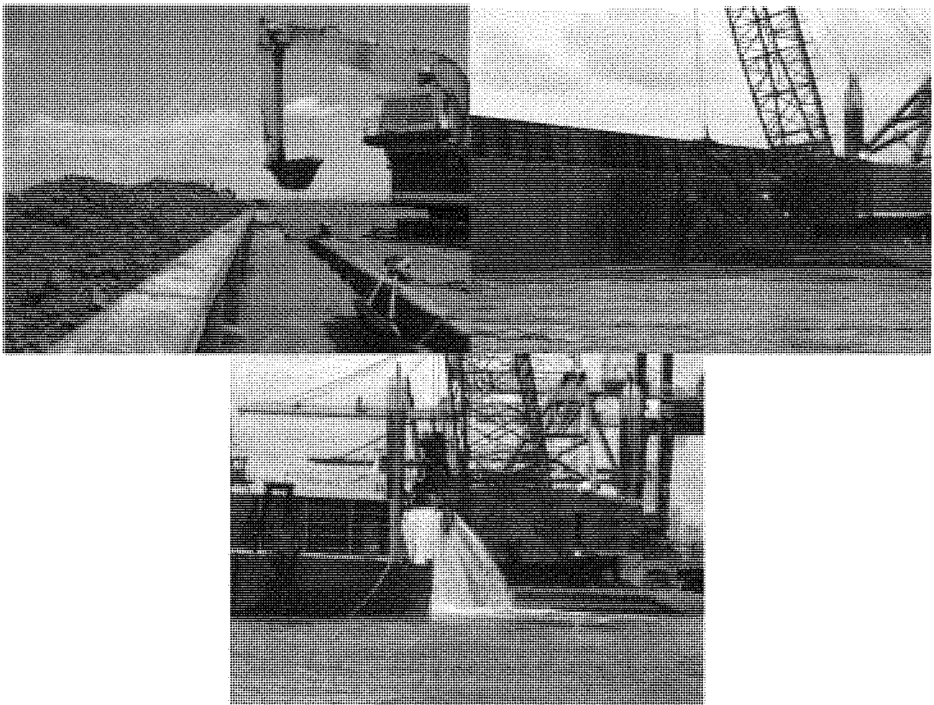


Figure 8 - Mechanical dredges (clamshell bucket/back-hoe dredge and barge). (Video of clamshell dredge - http://el.erdc.usace.army.mil/dots/doer/anima/clamshel.avi.)

Dredged Material Disposal

As previously stated, for the Port Everglades project, two disposal options are available. The first the disposal option is placement of dredged material in the EPA designated ODMDS located approximately four statute miles east of the entrance of the Port Everglades outer entrance channel in water depths ranging from 640-705 feet. Detailed information concerning this site is located on EPA's Ocean Dumping homepage located at http://www.epa.gov/region4/water/oceans/sites.html#portevergladesharbor and the Corps' Environmental documents website - http://www.saj.usace.army.mil/Divisions/Planning/Branches/Environmental/DocsNotices_OnLine_BrowardCo_PBPE.htm. The second disposal option is the potential creation of a potential artificial reef for mitigation with rock dredged from the project area. Any unconsolidated material in the channel (beach quality sand) that may have filled in the channel south of the south jetty, may be removed by a hopper dredge and placed in accordance with the Environmental Assessment for Operations and Maintenance Dredging completed with a Finding of No Significant Impact signed on April 28, 2005, that the Corps completed two ESA consultations for in 2004 and 2012, both resulting in concurrence with the Corps' determination that O&M dredging of Port Everglades was either already covered by the 1997 South Atlantic Regional Biological Opinion (NMFS, 2004) or a determination that placement of beach quality O&M material, "may affect, but is not likely to adversely affect" listed species under NMFs' purview. Additionally, NMFS concurred that the placement of beach quality O&M material was not likely to adversely modify designated critical habitat offshore of the dredged material placement area, John U Lloyd state park (NMFS, 2012).

Transportation Methodology – Hopper Dredges, Tugs/Scows, and Barges

Depending on the dredging and disposal site conditions, as a component of hydraulic and mechanical dredging operations, accompanying equipment such as tugs and barges (hopper, scow, spider barge, etc.) may be used in association with dredging activity in order to transport the dredged material to the pre-determined disposal sites. Methods of transporting dredged material to disposal sites include self propelled transport via hopper dredges or towing/pushing of loaded barges to disposal sites via tugboats. Tugboats are a component of all dredging operations and may be used to move immobile equipment into place as well as towing loaded barges to the disposal sites. Hopper dredges or bucket and barge operations are often used when disposal areas are beyond the pumping distance of pipeline dredges considering that hopper dredges and barges can transport material over long distances to the placement/disposal sites. Depending on a myriad of factors such as the type of dredged material, cubic yardage to be dredged, barge capacity, overflow capability, distance of the placement/disposal site, weather, etc., there may be types of dredges that consistently rotate from the dredge site to the placement/disposal site to achieve maximum efficiency and productivity. The number of hopper loads or barges towed, the transport interval, and the speed to the placement/disposal site will vary depending on these factors.

Hopper/scow locations are monitored at all times via the Dredging Quality Management (DQM) system and the contractor can be penalized for violating the specifications. The ullage (loaded draft) of each scow is recorded approximately every 30-seconds to determine if there is any loss of material from the scow during transit. This data is reviewed after each load by the contractor and the Corps/EPA and if the if a barge has a net loss of more than one foot in draft between the dredge site and disposal site(s) (averaged between the bow and stern monitoring locations), this serves as a "red flag" to conduct an investigation as to why the draft loss occurred. If the draft loss can be determined due to high seas and sloshing of material, no other action is required. However, if the loss is not as a result of high seas and sloshing, the barge is temporarily removed from the rotation and has the seals tested and repaired (if necessary). If a particular barge demonstrates a trend of material loss that does not resolve itself after seal testing and repair, the barge is removed from the dredging operation. One-foot of loss has been determined by Corps and EPA to be a good threshold for notification, because all barges have some amount of draft loss through leakage or water sloshing out of the barge due to sea conditions and weather, although the amount is typically minimal.

Hopper dredge and scows will be loaded with dredged material and taken to the ODMDS or approved artificial reef site. As part of the Corps' standard environmental protection specifications, the vessels are required to remain the marked channel until passing the outer buoy to prevent any accidental release of material from the scow/hopper that might settle on adjacent reef habitats.

> *"Due to the presence of hardbottom reefs adjacent to the channel, the Contractor shall stay within the marked entrance channel while in transit from the dredging area to the ODMDS, and on the return trip, until past the last channel marker."*

Hopper dredge and disposal tug/scow transit tracks will be recorded by the Contractor and reviewed within 24 hours of the transit to the disposal site to ensure the vessel remained in the marked channel or approved corridor to the mitigation site. If the dredge/tug & scow leaves the channel or approved corridor, the location will be marked and recorded in GIS, water depths of the location will be determined by reviewing existing surveys and, draft of the vessel will be determined by the DQM system. If it is determined that the potential exists for an impact to have occurred as a result of the vessel leaving the channel or approved corridor, a survey team will be deployed to assess any impact that may have occurred and conduct immediate remediation. Remediation work (including re-attachment of scleractinian corals and octocorals) will be conducted immediately after the survey by the survey crew. Remediation activities should follow the FLDEP-SEFCRI "Rapid Response and Restoration for Coral Reef Injuries in Southeast Florida, Guidelines and Recommendations" dated June 2007.

Split Hull Barge

A split hull barge (Figure 9) has two hulls connected with hinges at the front and back. The two-door hinged configuration, allows the hulls to swing apart, opening at the bottom to allow dredged material to fall from the barge. This provides a rapid disposal of dredged material, which, as a result, is placed within a small area. The rapid descent of material through the water column reduces the potential for resuspension of sediments into the water column during disposal. Such a barge may be used for ODMDS disposal. A rubber seal (similar to a gasket or weather-stripping on a door), is pinched between the two doors, limiting the leakage from the barge of water and dredged material. This seal does not prevent 100% of water and dredged material from leaking; however it minimizes it to the maximum extent practicable. During transport, the barge's draft and ullage are monitored and recorded and this data is reviewed after each load to detect loss of draft, which is assumed to represent loss of material. If a barge has a net loss of more than one foot in draft between the dredge site and disposal site(s) (averaged between the bow and stern monitoring locations), this serves as a "red flag" to conduct an investigation as to why the draft loss occurred. If the draft loss can be determined due to high seas and sloshing of material, no other action is required. However, if the loss is not as a result of high seas and sloshing, the barge is temporarily removed from the rotation and has the seals tested and repaired (if necessary). If a particular barge demonstrates a trend of material loss that does not resolve itself after seal testing and repair, the barge is removed from the dredging operation. One-foot of loss has been determined by Corps and EPA to be a good threshold for notification, because all barges have some amount of draft loss through leakage or water sloshing out of the barge due to sea conditions and weather, although the amount is typically minimal.

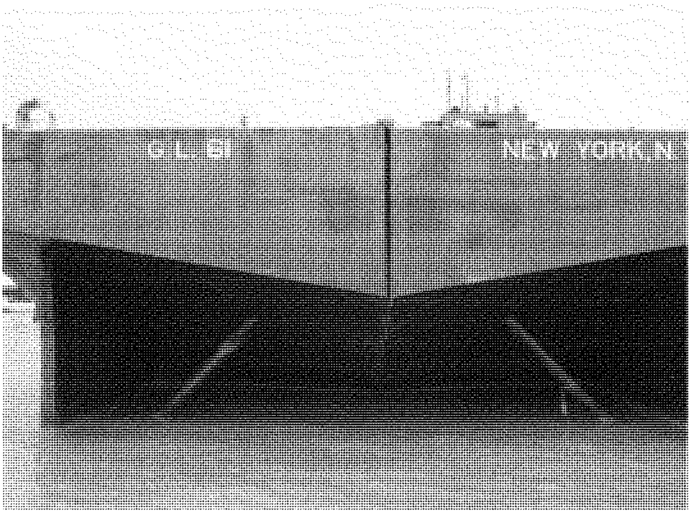


Figure 9 - Split-hull barge

Bottom Dump Barge

A bottom dump barge has doors on the bottom of the hopper, which opens at the disposal site to allow the dredged material to fall to the bottom. This type of barge has slower disposal than split hull dump barges and material spreads over a larger area. This barge may be used for ODMDS disposal. As with split hull barge, the bottom dump barge has seals around each of the doors to minimize leakage of material and water from the barge. The barge is monitored in the same method as the split hull barge and the same response is taken if the barge loses more than a net foot of draft. This type of barge may be used either for ODMDS disposal or construction of artificial reef sites.

Flat Top Barge

A flat top barge transports dredged material stacked on a barge deck and must be unloaded mechanically at the disposal site. As a result disposal time is slow but it is possible to drain dredged material with filters prior to disposal.

All three barge types are typically pushed or pulled to the disposal site by a tug (Figure 10) and for split hull and bottom dump barge, the disposal action is triggered remotely from the tug to the barge. The exact time the signal is given to the barge, and when the doors open and close are recorded in a tracking system for further data analysis and compliance tracking.

Figure 10 - Split Hull Barge Being Pushed by Tug

NMFS has previously consulted on disposal operations at the Port Everglades ODMDS under the EIS for designation of the ODMDS with EPA and determined "that adverse impacts were unlikely to occur to the shortnose sturgeon, smalltooth sawfish, or any of the whale and turtle species listed above as a result of project activities" (EPA 2005) and with the Corps (NMFS 2004).

Rock Pre-Treatment with Confined Blasting

The focus of the proposed blasting work at Port Everglades is to pre-treat bedrock prior to removal by a dredge utilizing confined blasting, meaning the shots would be "confined" in the rock. In confined blasting, each charge is placed in a hole drilled in the rock approximately 5-10 feet deep below the desired depth (see Figure 11) depending on how much rock needs to be broken and the intended project depth. The hole is then capped with an inert material, such as crushed rock (Figure 12; each bag as shown contains approximate volume of material used per discharge). This process is referred to as "stemming the hole." The blasting charge is set and then the chain of explosives within the rock is detonated.

For the Port of Miami Phase II expansion in 2005, which used confined blasting as a pre-treatment technique, the stemming material was angular crushed rock. The optimum size of stemming material is material that has an average diameter of approximately 0.05 times the diameter of the blast hole. Material must be angular to perform properly (Konya 2003). For the Corps project, project-specific specification will be prepared by the geotechnical branch of the District. In the Miami Harbor Phase II project, the following requirements were in the specifications regarding stemming material:

"*1.22.9.20 Stemming.* All blast holes shall be stemmed. The Blaster or Blasting Specialist shall determine the thickness of stemming using blasting industry conventional stemming calculation. The minimum stemming shall be 2 feet thick. Stemming shall be placed in the blast hole in a zone encompassed by competent rock. Measures shall be taken to prevent bridging of explosive materials and stemming within the hole. Stemming shall be clean, angular to subangular, hard stone chips without fines having an approximate diameter of 1/2-inch to 3/8-inch. A barrier shall be placed between the stemming and explosive product, if necessary, to prevent the stemming from settling into the explosive product. Anything contradicting the effectiveness of stemming shall not extend through the stemming."

It is expected that the specifications for any construction utilizing blasting at Port Everglades would have similar stemming requirements as those that were used for the Miami Harbor Phase II project. The length of stemming material will vary based on the length of the hole drilled, however minimum lengths will be included in the project specific specifications. Studies have shown that stemmed blasts have up to a 60-90% decrease in the strength of the pressure wave released, compared to open water blasts of the same charge weight (Nedwell and Thandavamoorthy, 1992; Hempen *et al.* 2005; Hempen *et al.* 2007). However, unlike open-water, i.e., unconfined blasts (Figure 13), very little peer-reviewed research exists on the effects that confined blasting can have on marine animals near the blast (Keevin *et al.* 1999). The visual evidence from a typical confined blast is shown in Figure 14.

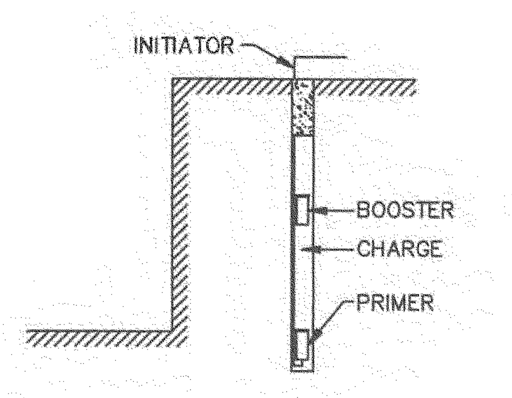


Figure 11 - Typical Stemmed Hole for Loading Charges

Figure 12 - Stemming Material and model for scale

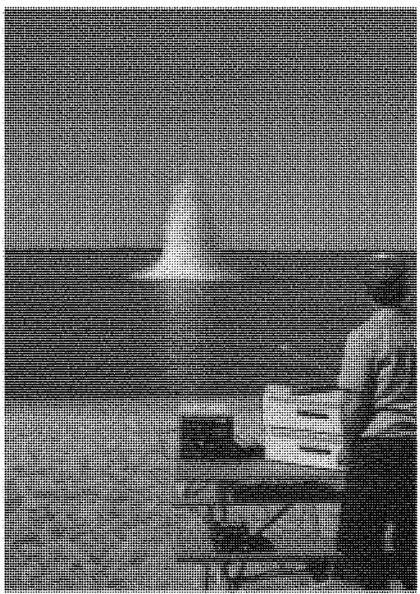


Figure 13 - Unconfined Blast of Seven Pounds of Explosives

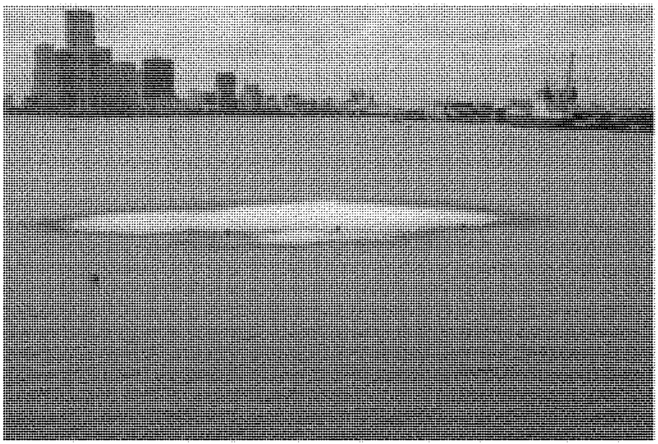


Figure 14 - Confined Blast of 3,000 Total Pounds of Explosives

To estimate the maximum poundage of explosives that may be utilized for this project, Corps has reviewed two previous blasting projects, one at San Juan Harbor, Puerto Rico in 1994 and one at Miami Harbor in 2005. The San Juan Harbor project's heaviest delay was 375 lbs per delay and in Miami it was 376 lbs per delay. Based on discussions with Corps's geotechnical engineers, it is expected that the maximum weight of delays for Port Everglades will be larger since the rock is much harder than what is seen at the Port of Miami. It is unknown at this time what the maximum delay weight will be for Port Everglades. This will be determined during the test blast program.

Minimization of Confined Blasting Impacts to Fish and Wildlife

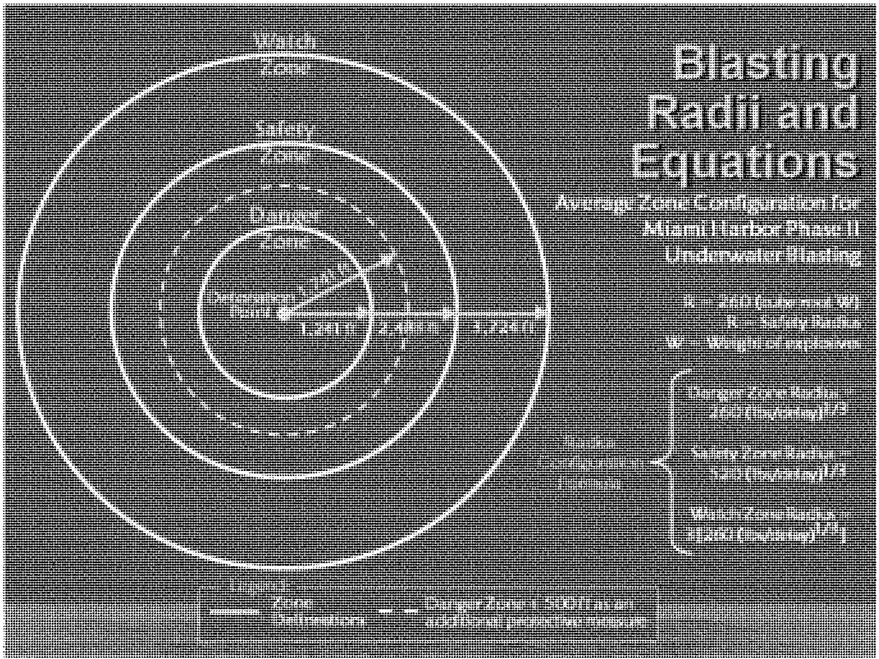
Blast specifications. Although the rock at Port Everglades is believed to be harder than Miami or San Juan Harbors, as noted above, Corps biologists, working with senior geologists, concluded that the assumptions set forth concerning minimization of the effects of blasting are applicable and accurate for the Port Everglades project. To that effect, based upon industry standards and Corps Safety & Health Regulations, the blasting program may consist of the following:

1) The weight of explosives to be used in each blast will be limited to the lowest poundage of explosives that can adequately break the rock.
2) Drill patterns are restricted to a minimum of 8-foot separation from a loaded hole.
3) Hours of blasting are restricted from two hours after sunrise to one hour before sunset to allow for adequate observation of the project area for protected species.

4) Selection of explosive products and their practical application method must address vibration and air blast (overpressure) control for protection of existing structures and marine wildlife.
5) Loaded blast holes will be individually delayed to reduce the maximum pounds per delay at point detonation, which in turn will reduce the mortality radius.
6) The blast design will consider matching the energy in the "work effort" of the borehole to the rock mass or target for minimizing excess energy vented into the water column or hydraulic shock.
7) Delay timing adjustments to a minimum of 8 ms between delay detonations to stagger the blast pressures and prevent cumulative addition of pressures in the water.

Safety radii. Furthermore, the confined blasting program will incorporate the use of three safety radii (Figure 15) typically utilized for projects involving unconfined blasts. This conservative use of an *unconfined* blast in development of the safety radii for a *confined* blast will increase the protections afforded marine species in the area. These three zones are referred to as the "Danger zone" – which is the inner most zone, located closest to the blast; the "Safety zone" – which is the middle zone and the "Watch zone" the outer most zone.

The danger zone radius will be calculated to determine the maximum distance from the blast at which mortality to protected marine species is likely to occur. The danger zone was determined by the amount of explosives used within each delay (which can contain multiple boreholes). These calculations are based on impacts to terrestrial animals in water when exposed to a detonation suspended in the water column (unconfined blast) as researched by the U.S. Navy in the 1970s (Yelverton *et al.* 1973; Richmond *et al.* 1973) as well as observations of sea turtle injury and mortality associated with unconfined blasts for the cutting of oil rig structures in the Gulf of Mexico (Young 1991). The reduction of impact by confining the shots would more than compensate for the presumed higher sensitivity of marine species. Corps believes that the danger zone radius, coupled with a strong protected species observation and protection plan is a conservative, but prudent, approach to the protection of marine wildlife species. Based on a review by NMFS-OPR for the Miami Harbor phase II project, where these radii were first used, NMFS and FWS found these protective measures sufficient to protect marine mammals under their respective jurisdictions (NMFS 2005c; FWS 2002, NMFS 2011).



These zone calculations will be included as part of the specifications package that the contractors will bid on before the project is awarded. Ideally the safety radius should be large enough to offer a wide buffer of protection for marine animals while still remaining small enough that the area can be intensely surveyed.

Radii specifications are as follows:

1) Danger Zone: The radius in feet from the detonation beyond which no expected mortality or injury from an open water explosion is likely to occur (NMFS 2005). The danger zone (ft) = 260 [79.25 m] X the cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

2) The Safety Zone is the approximate distance in feet beyond which injury (Level A harassment as defined in the MMPA) is unlikely to occur from an open water explosion (NMFS 2005). The safety zone (ft) = 520 [158.50 m] X cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

3) The Watch Zone is three times the radius of the Danger Zone to ensure that animals entering or traveling close to the Exclusion Zone are spotted and appropriate actions can be implemented before or as they enter any impact areas (i.e., a delay in blasting activities).

4) Exclusion Zone extends to 500 feet outside the Danger Zone radius. Detonation will not occur if a marine mammal or reptile may be within that zone (based on observational data).

It is crucial to balance the demands of the blasting operations with the overall safety of protected species in the project area. A radius that is excessively large will result in significant delays that prolong the blasting, construction, traffic and overall disturbance to the area. A radius that is too small puts the animals at too great of a risk should one go undetected by the observers and move into the blast area. Because of these factors, the goal is to establish the smallest radius possible without compromising animal safety and provide adequate observer coverage for whatever radius is agreed upon.

Monitoring/watch plan.
A watch plan will be formulated based on the required monitoring radii and optimal observation locations. The watch plan will be consistent with the program that was utilized successfully at Miami Harbor in 2005 and will consist of at least five observers including at least one (1) aerial observer, two (2) boat-based observers, and two (2) observers stationed on the drill barge (Figures 16, 17, 18 & 19). The 6th observer will be placed in the most optimal observation location (boat, barge, fixed structure or aircraft) on a day-by-day basis depending on the location of the blast and the placement of dredging equipment, as determined by the blaster in charge and the chief protected species observer. This process will insure complete coverage of the three zones as well as any critical areas. The watch will begin at least one-hour prior to each blast and continue for one-half hour after each blast (Jordan *et al.* 2007).

A blast-day (or blast-event) is made up of all the actions during a blast from the Notice to Project Team and Local Authorities two hours before the blast is detonated through the end of the protected species watch 30 minutes after the blast detonation. The typical events in a blast-event are:

<u>Typical Blast Timeline</u>

- T minus 2 HOURS - Notice to Project Team and Local Authorities
- T minus 1 HOUR - Protected Species Watch Begins
- T minutes 15 MINUTES - Notice to Mariners (channel closes)
- T minus 1 MINUTE - Fish Scare
- Blast detonation
- T plus 5 MINUTES - All Clear Signal
- T plus 30 MINUTES - Protected Species Watch Ends
- DELAY CAPSULE (can occur between T - 1 hour and detonation): If an animal is observed in either the danger or safety zones, the blast is delayed to monitor the animal until it leaves, on its own, from both the danger and safety zones

This timeframe lasts a minimum of 2 hours and 35 minutes, although it can be extended if a protected species (like a dolphin or turtle) enters the exclusion zone. The animal is monitored until it leaves, on its own, from both the danger and exclusion zones. There can be more than one blast-day (blast event) in a calendar day, although two is typically the maximum.

Data provided by Broward County Aviation Department on June 22, 2004 indicated that there do not appear to be flight path/altitude conflicts with a helicopter hovering 300-400 feet from the water surface in the MTB/upper SAC. Specific flight and observing plans will be coordinated with the FAA and Broward County Aviation Department to determine if aerial overflights are authorized throughout the entire project area due to the Port's proximity to Fort Lauderdale/Hollywood International Airport (FLL). If any conflicts develop due to the proximity of FLL to the Port that would prevent overflights of specific areas of the project that have been determined to require blasting, alternative monitoring methodologies will be investigated and coordinated with the resource agencies with jurisdiction for those issues. During the blasting conducted at Port Everglades in 1981, boat-based manatee surveys were conducted using a color fish-finder and located two additional manatees that were not located by aerial observers.

Figure 16 - Typical observer helicopter

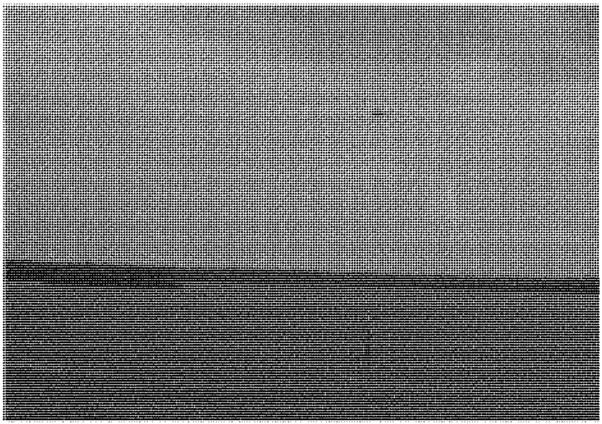


Figure 17 - View of typical altitude of aerial observer operations

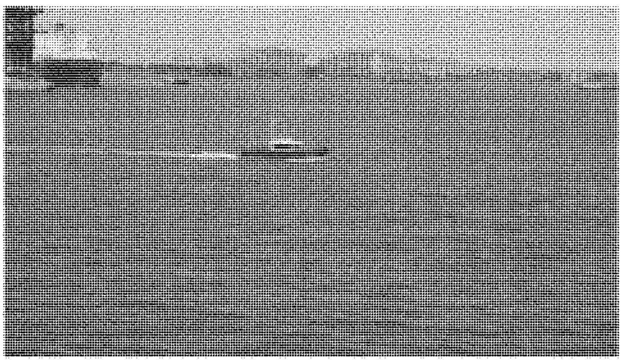


Figure 18 - Typical vessel for boat-based observer

Figure 19 - Observer on Drill Barge

Fish repulsion.
In the past, to reduce the potential for fish to be injured or killed by the blasting, Corps has allowed, and the resource agencies have requested, that blasting contractors utilize a small, unconfined explosive charge, usually a 1-lb booster, detonated about 30 seconds before the main blast to drive fish away from a blasting zone. It is assumed that noise or pressure generated by the small charge will drive fish from the immediate area, thereby reducing impacts from the larger and potentially more-damaging blast. Blasting companies use this method as a "good faith effort" to reduce potential impacts to aquatic resources. The explosives industry recommends firing a "warning shot" to frighten fish out of the area before seismic exploration work is begun (Anonymous 1978 in Keevin *et al.* 1997).

There is limited data available on the effectiveness of fish scare charges at actually reducing the magnitude of fish kills and the effectiveness may be based on the fish's life history. Some states require the use of fish scares (Illinois, New Jersey and Washington) while others (Alaska and Texas) have determined that they are ineffective and "potentially harmful to piscivorous fishes, marine mammals and birds which are attracted to feed on fish that are stunned or wounded by the repelling charge." Florida does not have a regulation specific to the use of scare charges associated with blasting (Lisa Gregg, pers. Comm., August 5, 2011), but FWC has requested the use of scare charges associated with previous projects that utilized blasting like the 2005 blasting at Miami Harbor. Numerous incidental observations (cited in Keevin *et al.* 1997) during blasting operation suggest that these charges are not effective in scaring fish from the blasting zone.

Keevin *et al.* (1997) conducted a study to test if fish scare charges are effective in moving fishes away from blast zones. They used three freshwater species, largemouth bass; channel catfish and flathead catfish, equipping each fish with an internal radio tag to allow the fishes movements before and after the scare charge to be tracked. Fish movement was compared with a predicted LD 0% mortality distance for an open water shot (no confinement) for a variety of charge weights. Largemouth bass showed little response to repelling charges and none would have moved from the kill zone calculated for any explosive size. Only one of the flathead catfish and two of the channel catfish would have move to a safe distance for any blast. This means that only 11% of the fish used in the study would have survived the blasts.

These results call into question the true effectiveness of this minimization methodology; however, some argue that based on the monetary value of fish (American Fishery Society 1992 in Keevin *et al.* 1997) including high value commercial or recreational species like snook and tarpon found in southeast Florida inlets like Port Everglades, the low cost associated with repelling charge use would be offset if only a few fish were moved from the kill zone (Keevin *et al.* 1997).

Vibration and Pressure Monitoring

Vibration.

In an urban environment such as the Port, which is surrounded by commercial properties, utilities, and residential communities, protection of structures must be considered. Once the areas of the project requiring blasting have been identified, critical structures within the blast zones would be determined. Where vibration damage may occur, energy ratios and peak particle velocities shall be limited in accordance with state or county requirements, whichever is more stringent. Furthermore, vibration-monitoring devices will be installed to ensure that established vibration limits are not exceeded. If the energy ratio or peak particle velocity limits are exceeded, blasting will be stopped until the probable cause has been determined and corrective measures taken. Critical monitoring locations may include structures such as bulkheads, hazardous materials storage areas, and buried utilities.

Ground-borne vibration can be generated by a number of sources, including road and railways, construction activities such as piling, blasting and tunneling. Vibration can be defined as regularly repeated movement of a physical object about a fixed point. The parameter normally used to assess the ground vibration is the peak particle velocity (PPV) expressed in millimeters per second (mm/s). In order to completely define ground vibration, the amplitude and frequency of the motion are measured in the three orthogonal directions generally in terms of velocity which is considered to be the best descriptor for assessing human comfort and the potential damage response of structures. The vibration velocity signals are summed (in real time) and the maximum amplitude of this vector sum is defined as the Peak Vector Sum (PVS). Vibration can cause varying degrees of damage in buildings and affect vibration-sensitive machinery or equipment. Its effect on people may be to cause disturbance or annoyance or, at higher levels, to affect a person's ability to work.

Corps reviewed data from the two most recent blasting projects completed by the district: the deepening of San Juan Harbor in 2000 and of Miami Harbor in 2005. Both used confined underwater blasting. Both projects had significant structural resources located near the blast that were of concern (the San Juan site included the National Park Service's Castillo San Felipe del Morro, a 400+ year old fortress overlooking the harbor and 30 additional historic sites within boundaries of the National Monument). In Miami, the harbor is bounded on the north by the port facilities and on the south by Fisher Island, a residential island. In both cases, a network of monitoring locations was established by the blasting contractor to capture vibration associated with the detonation of each blast. Additionally, at El Morro, the contractor installed monitoring devices on each crack in the stucco that covers the structure's interior walls, and a photo was taken after installation to serve as a pre-construction baseline. During construction, the crack was monitored throughout the blasting project to ensure that crack's width or length had not increased (Figure 20).

At Miami the maximum PVS allowed for the project was 1.0 mm/s. The average maximum PVS for the Miami Harbor deepening in 2005 was 0.3828mm/s with a range of 0.0819mm/s - 1.08mm/s during the 40 blast detonations. During both projects, no adverse impacts were reported to any of the surrounding structures by either the vibration monitoring contractor, or the building's owners/trustees.

Air Pressure.
The Corps Safety and Health Requirements Manual (EM 385-1-1 3, September 1996) limits of "air blast pressure exerted on structures resulting from blasting shall not exceed 133 dB (0.013 psi)" and industry standard vibration limitations would be incorporated into the design process. A conservative regression analysis of similar projects may be used to develop the design and then continually updated with calibration of the environment. The contractor will also be required to abide by state and local blasting requirements in addition to the Corps Safety Manual previously referenced in this paragraph.

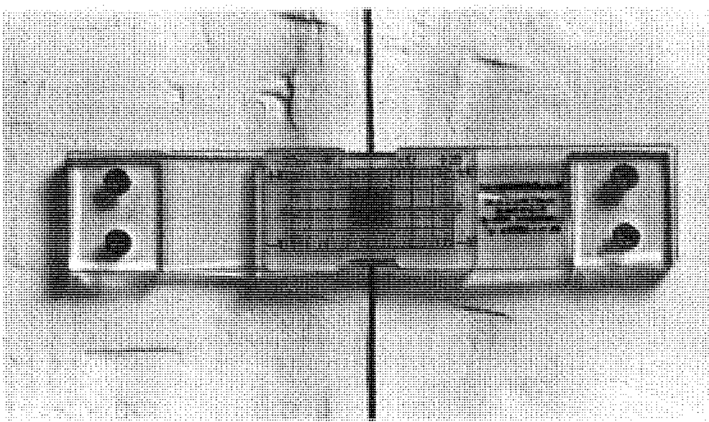


Figure 20 - Typical Crack Monitor Device

Duration of Confined Blasting During Construction
The duration of the blasting (pre-treatment) is dependent upon a number of factors including hardness of rock, how close the drill holes are placed, and the type of equipment that will be used to remove the pretreated rock. For comparison, the harbor deepening project at Miami Harbor in 2005-2006 estimated between 200-250 days of blasting with one-shot per day (a blast-day) to pre-treat the rock associated with that project. However, the contractor completed the project in 38 days with 40 blasts. The upcoming expansion at Miami Harbor scheduled to begin in spring of 2013 currently estimates 600 blast-days for the entire project footprint. However, the actual number of blast days may be reduced by the selected contractor, based on the previously mentioned factors. Using both Miami projects as a guide, and recognizing that 50% of the project footprint has been identified as possibly needing pre-treatment based on current information, Corps estimates approximately 900 blast-days for the Port

Everglades project, out of the total five years of uninterrupted construction, approximately 1,825 calendar days. This estimate is subject to change based on more detailed geotechnical analysis during the preconstruction, engineering and design (PE&D) phase of the project.

Adaptive Improvement of Blasting Specifications and Methods

Test Blast Program.

Prior to implementing a construction blasting program a test blast program will be completed. The test blast program will have all the same protection measures in place for protected species monitoring and protection as blasting for construction purposes. The purpose of the test blast program is to demonstrate and/or confirm the following:

- Drill Boat Capabilities and Production Rates
- Ideal Drill Pattern for Typical Boreholes
- Acceptable Rock Breakage for Excavation
- Tolerable Vibration Level Emitted
- Directional Vibration
- Calibration of the Environment

The test blast program begins with a single range of individually delayed holes and progresses up to the maximum production blast intended for use. The test blast program will take place in the project area and will count toward the pre-treatment of material, since the blasts of the test blast program will be cracking rock. Each test blast is designed to establish limits of vibration and air blast overpressure, with acceptable rock breakage for excavation. The final test event simulates the maximum explosive detonation as to size, overlying water depth, charge configuration, charge separation, initiation methods, and loading conditions anticipated for the typical production blast.

The results of the test blast program will be formatted in a regression analysis with other pertinent information and conclusions reached. This will be the basis for developing a completely engineered procedure for construction blasting plan. During the testing the following data will be used to develop a regression analysis:

- Distance
- Pounds Per Delay
- Peak Particle Velocities (TVL)
- Frequencies (TVL)
- Peak Vector Sum
- Air Blast, Overpressure

Fish Kill Monitoring.
In addition to monitoring for protected marine mammals, sawfish and reptiles in the area during blasting operations, Corps will work with the resource agencies to develop a monitoring plan for fish kills associated with each blasting event. This effort may be similar to the effort that was developed by FWC in association with the Port of Miami Phase II project, and is currently a requirement of the Miami Deepening project scheduled to start in the spring of 2013. This plan will be developed in detail during the PE&D portion of the project, but may include collection, enumeration and identification of dead and injured fish floating on the surface after each blast. In addition, blast data will be collected from the daily blasting reports provided after each shot by the blasting contractor, in addition to environmental data such as tidal currents (in-coming or out-going). Due to health and safety restrictions, all collections will be made from the surface only. No diving to recover fish carcasses is authorized.

Coordination.
As part of the development of the protected species protection and observation protocols, which will be incorporated into the plans and specifications for the project, Corps will continue to coordinate with the resource agencies (specifically BCEPD, NMFS, FWC, FWS and EPA) and NGOs to address concerns and potential impacts associated with the use of blasting as a construction technique.

Study Data.
In addition to coordination with the agencies and NGOs, findings from any new scientific studies regarding the effects of blasting (confined or unconfined) on species that may be in the area (marine mammals, sea turtles, fishes (both with a swim bladder and without) and reptiles will be incorporated into the design of the protection measures that will be employed in association with confined blasting activities in the port. Examples of these studies may include:

- "Caged Fish Study". As part of the August 1 & 2, 2006 After Action Review conducted for the Miami Harbor Phase II dredging project, which included blasting as a construction technique, Corps, in partnership with FWC, committed to conduct a study on the effects of blast pressures on finfishes with air bladders in close proximity to the blast. This study would attempt to answer the questions regarding proximity to the blast array, injury and death associated with confined blasting not resolved with research conducted with the Wilmington Harbor blasting conducted in 1999 (Moser 1998 and Moser 1999). This study is expected to be completed as part of the Miami Harbor 2013-2015 dredging project.
- Other blasting project monitoring reports for projects, both from inside and outside of Florida using confined underwater blasting as a construction technique completed prior to development of plans and specifications.

Conclusion.
Corps has concluded that confined blasting is the *least* environmentally impactful method for pre-treatment of hard, consolidated rock in the Port. Each blast will last no longer than 15 seconds in duration, and may even be as short as two seconds. Additionally, the blasts are confined in the rock substrate with stemming. Because the blasts are confined within the rock structure, the distance of the blast effects are reduced significantly as compared to an unconfined blast (Nedwell and Thandavamoorthy 1992; Hempen *et al.* 2005; Hempen *et al.* 2007).

Protected Species Under NMFS Jurisdiction Included in this Assessment
The following endangered (E) and threatened (T) species under the jurisdiction of NMFS may occur in or near the action area:

Common Name	Scientific Name	Status
Marine Mammals		
Blue whale	*Balaenoptera musculus*	E
Fin whale	*Balaenoptera physalus*	E
Sei whale	*Balaenoptera borealis*	E
Humpback whale	*Megaptera novaeangliae*	E
Sperm whale	*Physeter macrocephalus*	E
North Atlantic Right whale	*Eubalaena glacialis*	E
Sea Turtles		
Loggerhead sea turtle	*Caretta caretta*	E/T
Hawksbill sea turtle	*Eretmochelys imbricate*	E
Leatherback sea turtle	*Dermochelys coriacea*	E
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
Green sea turtle	*Chelonia mydas*	E/T
Fish		
Smalltooth sawfish	*Pristis pectinata*	E
Plants		
Johnson's seagrass	*Halophila johnsonii*	T
Invertebrates		
Elkhorn coral	*Acropora palmata*	T
Staghorn coral	*Acropora cervicornis*	T

Critical Habitat
ESA-designated critical habitat for elkhorn and staghorn coral occurs within the action area.

The Corps has reviewed the biological, status, threats and distribution information presented in this assessment and believes that the following species will be in or near the action area and thus may be affected by the proposed project: four sea turtle species; Johnson's seagrass and smalltooth sawfish.

Marine Mammals

The full analysis of the life history of each of the six marine mammals in the impact area is provided in detail in the September 2004 Biological Assessment found in Appendix 2. The status of the six species has not changed since that analysis was conducted and it is incorporated by reference. These six species of endangered marine mammals may be found seasonally in the waters offshore southeastern Florida.

NMFS has previously consulted on effects of a large scale navigation expansion project (Miami Harbor) approximately 20 miles south of the Port Everglades project area for all six large whale species in 2003 and 2011. The same construction methodologies are being proposed for Port Everglades that were consulted on for Miami Harbor, and the same populations of the six large whale species were evaluated. Specifically NMFS said:

> "Blue, fin, sei, and sperm whales are predominantly found seaward of the continental shelf. Northern right whales and humpback whales are coastal animals and have been sighted in the nearshore environment in the Atlantic along the southeastern United States from November through March on their migration south. Right whales are rarely sighted south of northeastern Florida. None of these whale species are expected to be found in the shallow waters inshore of the outer reef. NOAA Fisheries believes that these whales could be affected by the use of explosives offshore of the outer reef; however, the COE has modified the proposed action such that explosives are not expected to be used seaward of the outer reef. NOAA Fisheries believes that this change in the proposed action, in combination with the above mentioned mitigation measures decreases the effects of the proposed action on listed whales to insignificant levels. If the COE decides to use explosives seaward of the outer reef they must reinitiate consultation as NOAA Fisheries believes that this may affect listed whale species." (NMFS, 2003a)
>
> "North Atlantic Right Whales and Humpback Whales
>
> North Atlantic right whales and humpback whales may be found in or near the action area. NMFS has analyzed the routes of potential effects on North Atlantic right whales and humpback whales from the proposed action and, based on our analysis, determined that potential effects are limited to the following: injury from potential interactions with construction (i.e., dredging) equipment (e.g., a dredge vessel striking a whale), injury from use of explosives, and temporary avoidance of the area during construction operations. The proposed project is not located in or near right whale calving areas. The COE will require the contractor to follow the safety conditions for blasting (noted in Section 3.1 above), therefore, NMFS concludes that the project's construction effects are discountable. In addition, the contractors will be required to abide by the NMFS' Vessel Strike Avoidance and Reporting guidelines. With implementation of these conservation measures, NMFS believes that the likelihood of right whales and humpback whales being adversely affected by the proposed action is discountable.
>
> Blue, Fin, Sei and Sperm Whales
>
> Blue, fin, sei, and sperm whales are predominantly found seaward of the continental shelf and are not expected to be found within the shallow waters inshore of the outer reef. Effects to whales include the risk of injury from construction, which will be discountable due to the species' mobility. Blue, fin, sei and sperm whales may be affected by being temporarily unable to use the site due to potential avoidance of construction activities and related noise, but these effects will be insignificant. Disturbance from construction activities and related noise will be intermittent

and only occur during the day for part of the construction period and will not appreciably interfere with use of the area by listed species." (NMFS, 2011)

Sea Turtles

A summary of the life history and species status for each of the five species of sea turtles that may occur on the beaches of, or offshore of, Broward County are found in the Sept 2004 Biological Assessment and are incorporated by reference.

Broward County is within the normal nesting range of three species of sea turtles: the threatened loggerhead (*Caretta caretta*), the endangered green turtle (*Chelonia mydas*), and the endangered leatherback (*Dermochelys coriacea*). The endangered hawksbill sea turtle (*Eretmochelys imbricata)* has also been recorded nesting in the County on rare occurrences (Table 2). The majority of sea turtle nesting activity in Broward County occurs during the summer months of June, July and August, with nesting activity occurring as early as March and as late as September (Burney and Margolis 1999). The waters and habitats offshore of Broward County are also used for foraging and shelter for the three species listed above and possibly the hawksbill turtle and the Kemp's ridley turtle (*Lepidochelys kempii*) (USACE 2000). Due to the heavily developed nature of the Broward County coastline, the relative location of Highway A1A to the beach, and extensive beach front lighting, all of which have the potential to negatively impact nesting sea turtles and their hatchlings, Broward County has relocated all discovered nests at Pompano Beach, Deerfield Beach, Hollywood-Hallandale, and Fort Lauderdale since the inception of its sea turtle conservation program in 1978 (Burney and Margolis, 1998). In 2005, the State of Florida changed its policy regarding relocation of nests, and decreasing the number of nests relocated in Broward County to approximately 65-70% of the deposited nests countywide and then to about 28-30% of the nests in 2006 and 2007 (Lou Fisher, pers. com 2007). Sea turtle nests located within the boundaries of JUL are not typically moved unless their location is in jeopardy from storm surge, tidal inundation, or erosion (S. Leve and E. Cowan, pers com, 2011). If nests are relocated, they are typically moved south to a natural area with slightly higher elevation.

Table 2 Sea Turtle Nesting in Broward County: Number of Nests by Year and Species

Year	Green	Loggerhead	Leatherback	Hawksbill
2010	268	2,283	14	0
2009	71	1,808	45	0
2008	276	1,929	14	0
2007	233	1,593	41	0
2006	138	1,740	15	0
2005	208	1,819	25	2
2004	153	1,826	4	0
2003	78	2,335	12	0
2002	216	2,070	18	0
2001	26	2,321	39	0
2000	255	2,674	13	0
1999	24	2,584	12	0
1998	200	2,643	14	0
1997	29	2,216	42	0
1996	130	2,902	2	0
1995	52	2,567	15	0
1994	123	2,180	9	1

FWRI 2011 [Hawksbill data currently being confirmed for 2006-2010]

Between 1991-2009, 28 stranded sea turtles have been reported within or near Port boundaries: 16 loggerhead turtles, six green turtles, four hawksbill turtles, and two unidentified species. Of these 28, 13 were documented as incidental captures. one green turtle was caught on hook and line at John U Lloyd Beach State Park, and 12 (10 loggerheads, one green turtle, and one unknown) were caught in the FP&L power plant at Port Everglades (A. Foley, FWRI, pers com, July 29, 2011). Specific location information, i.e., latitude/longitude, for 2010 and 2011 have not yet been entered into the FWC database, so it is unknown if any strandings for those years were associated with the project area.

Fish - Smalltooth Sawfish

The smalltooth sawfish (*Pristis pectinata*) has a circumtropical distribution and has been reported from shallow coastal and estuarine habitats. In U.S. waters, *P. pectinata* historically occurred from North Carolina south through the Gulf of Mexico, where it was sympatric with the largetooth sawfish *P. perotteti* (west and south of Port Arthur, TX) (Adams and Wilson, 1995). Individuals have also historically been reported to migrate northward along the Atlantic seaboard in the warmer months. It also was an occasional visitor to waters as far north as New York.

Smalltooth sawfish, *P. pectinata,* were once common in Florida as detailed by the Final Smalltooth Sawfish Recovery Plan (NMFS 2009a) and are very rarely reported in southeast Florida. Their core range extends along the Everglades coast from the Ten Thousand Islands to Florida Bay, with moderate occurrence in the Florida Keys and at the mouth of the Caloosahatchee River. Outside of these areas, sawfish are rarely encountered and appear to be relatively rare (Simpfendorfer 2006). It does not appear to be a coincidence that the core range of smalltooth sawfish corresponds to the section of Florida with the smallest amount of coastal habitat modification. Corps requested sighting information from the FWC smalltooth sawfish sighting database on January 16, 2008 for the "area in and around Port Everglades, Broward County". In an email response dated January 16, 2008 FWC sawfish Biologist, Gregg Poulakis referred Corps to the FWC sawfish database previously provided to Corps in October 2007. A search of that database found a total of seven sightings of *P. pectinata* in Broward County between 1993 and 2007 ranging in size from 2.4-4.1 meters in length (FWC 2007). The locations of these sightings ranged from Pompano Beach through Lauderdale-By-the-Sea, including three sightings in the vicinity of the Port. In July 2011, Corps contacted FWC again, and was referred to NMFS-OPR, who has taken over management of the database. NMFS (via S. Norton, pers com) provided a figure of all of the smalltooth sawfish sightings throughout Broward County, which is shown below (Figure 21). NMFS provided data pertaining to a total of 15 individuals documented in Broward County between 2003-2011.

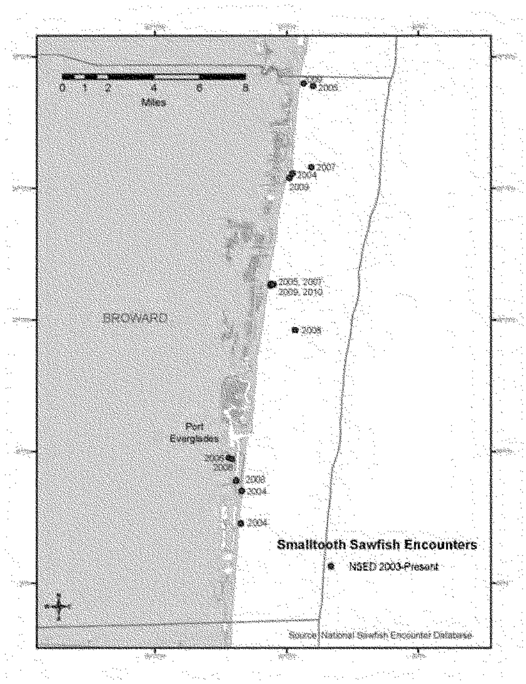


Figure 21 - Smalltooth sawfish observations, Broward County, Florida (2003-2011)

Possibly the most notable sighting of a *P. pectinata* in Broward County, in the vicinity of the Port took place at the Florida Power & Light (FP&L) Port Everglades power plant discharge canal on March 17, 2006 during an effort to capture an injured manatee in the canal (Figure 22). Based on data from FWC, the sawfish was approximately 10-12 feet

(120-144 inches) in length and was released from the manatee capture net without harm.

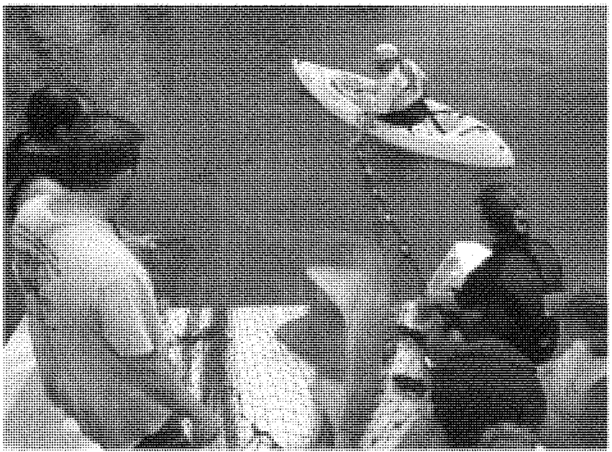


Figure 22 - Adult smalltooth sawfish incidentally captured in the FP&L power plant discharge canal

Habitat use by sawfish appears to be divided by animal size. Small sawfish (0-79 inches/0-200 cm) use shallow water areas as nursery areas often dominated by red mangrove habitats. The mangrove prop roots help serve as shelter against predation (NMFS 2009b and Simpfendorfer 2006). There is limited data available on habitat usage for large juvenile sawfish (>79 inches/201 cm). One tagged individual was recorded in water depths of less than 17 feet for 120-days (NMFS, 2006). Simpfendorfer found that a large percentage of animals greater than 300 cm (3 meters) in size were found in deeper water. Adult smalltooth sawfish use shallow coastal waters to deep shelf waters of up to 400 feet (NMFS 2009b). They may use navigation channels as a transit corridor between the shallow coastal and deeper water habitats. Mote Marine Laboratory (Simpfendorfer 2006) prepared a Habitat Suitability Index (HSI) for sawfish under contract to NOAA, for the entire state of Florida and found, that on a scale of 0-9 (with 9 being the best possible habitat for smalltooth sawfish), the water habitats in Broward county ranked between 2-3 on the HSI. This finding was based on the water depths adjacent to mangroves, distances to mangrove buffer and salinity. It should also be noted in that Broward County's tidal waterways are unique compared to other Florida coastal counties. Characterized as predominately linear, the marine waterways rarely exceed 1000 feet in width and most shorelines are stabilized with a seawall, rip-rap or other erosion control system (Broward County 2007). This determination by Simpfendorfer supports Corps's determination that the Port's existing habitats are not optimal for sawfish; the area is extremely limited for use by juveniles due to the lack of shallow water (less than one meter in depth) directly adjacent to large areas of mangroves. However, this does not mean that the areas near Port Everglades cannot support sawfish. This is also shown in the history of sawfish sightings in Broward County.

A review of the NOAA sawfish database provided one record of a sawfish smaller than two meters (168 cm), located offshore of Broward County near Pompano Beach, approximately 15 miles north of Port Everglades (Amanda Frick, NOAA, pers com, 25 July 2011). To date, no sawfish smaller than 2 meters (the size at which sawfish attain sexual maturity) has been documented within five miles of Port Everglades or within the boundaries of the Port.

NMFS released the final recovery plan for the smalltooth sawfish in January 2009 (NMFS, 2009), and designated critical habitat for the species in September 2009 (74 FR 45353).

Plants - Johnson's Seagrass

A detailed review of the biology and status of Johnson's seagrass is located in the September 2004 Biological Assessment and is incorporated by reference. *Halophila johnsonii* has the most limited geographic ranges of all seagrass species. It is known to occur only from 21.5 km north of Sebastian Inlet (i.e., near Palm Bay in Brevard County) south to northern Biscayne Bay (i.e., North Miami) on the east coast of Florida (Kenworthy 1997; Virnstein and Hall 2009). Although NMFS has listed *H. johnsonii* as a threatened species under Section 4 of the ESA, it has not promulgated a 4d rule under the Act, and as a result, there is no prohibition on take the *H. johnsonii*.

Seagrass habitat cover type, abundance, and density for the study area are described in the Environmental Baseline Surveys conducted in 1999, 2000, 2001, 2006 and 2009 (Figure 23). Additional surveys were carried out by Broward County in 2001 and 2004. The 1999 environmental baseline surveys for seagrasses occurred within the project area, which started approximately 1,200 feet north of the Port Inlet, then south along the IWW to approximately 1,000 feet south of the DCC juncture, and also along the DCC (DC&A 2001). In the 2000 survey, additional survey transects were located within the area 1,000 feet south of the DCC on the east side of the channel, and on the west side, from the DCC south to the Dania Beach Boulevard Bridge. Also, in order to field verify whether seagrass occurred in the OEC, as reported by the BCEPD staff (S. Higgins, Beach Erosion Administrator Broward County, pers com), an integrated video survey was performed within the OEC in 2001 (DC&A 2001). In 2006, thorough reconnaissance of the entire project area was completed, verifying that seagrasses were limited to the areas previously mapped in 1999 and 2000. After the reconnaissance effort, detailed seagrass surveys were conducted in the same project area as 1999 and 2000 field surveys (not including areas further south than approximately 1,000 feet south of the intersection of the DCC with the IWW (DC&A 2006)). In 2009, further thorough reconnaissance of the entire project area was completed, verifying that grasses remained in the previously mapped areas and had not established beds in new areas. After this reconnaissance effort, detailed seagrass surveys were conducted in the same project area as 2006 surveys (again, not including areas further south than approximately 1,000 feet south of the intersection of the DCC and the IWW) (DC&A 2009a; see Appendix D).

Several other seagrass surveys and anecdotal observations have occurred in the project area, including a Broward County seagrass survey in 2001, and a Broward County/FDEP QA/QC assessment for a previously conducted seagrass survey near the USN facility (the south side of the IEC) for a proposed Navy project in 2004. A permanent transect was established in April 2006 adjacent to the Coast Guard station to monitor annual changes in the documented *Halophila johnsonii* bed by Fish and Wildlife Research Institute (FWRI) (Jennifer Kunzelman, FWRI, pers comm, January 25, 2008). Also in 2008, seagrass surveys were conducted for Nova Southeastern University Oceanic Center's (NSUOC) boat basin and adjacent areas (Coastal Eco-Group 2008). Most recently in the summer of 2008, an interagency team conducted qualitative surveys within the project area. These studies have provided valuable supplemental information on seagrass populations changes and trends since 2001. In 2008 and 2009 Miller Legg conducted surveys for West Lake Park within the DCC portion of the project area. Due to the data collection methods, which may have included GPS point data in many cases, these data are not displayed in seagrass habitat maps, except for the 2009 dataset, which surveyed areas identified in the 2008 interagency survey effort.

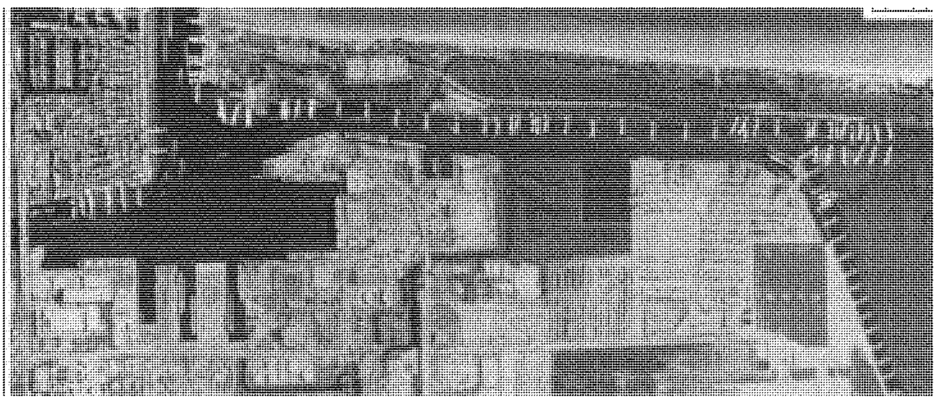


Figure 23 - Transect coverage of all Corps seagrass surveys

Results from seagrass surveys conducted for the project (DC&A 1999; DC&A 2001; DC&A 2006; DC&A 2009) demonstrated that *H. johnsonii* occurs within the SAC (see Figures 24 and 25). *H. johnsonii was* documented by at least one survey in all assessment areas except OEC and IEC. In 2006, *H. johnsonii* was not observed in two assessment areas where it was previously observed, however it returned to these areas in 2009. The expansion and contraction of *H. johnsonii*, also referred to as "pulsating patches" may be a long-term survival strategy (Virnstein *et al.* 2009). The persistent presence of high-density elevated patches of *H. johnsonii* on flood tidal deltas near inlets suggests that it is capable of sediment stabilization (NMFS 2007).

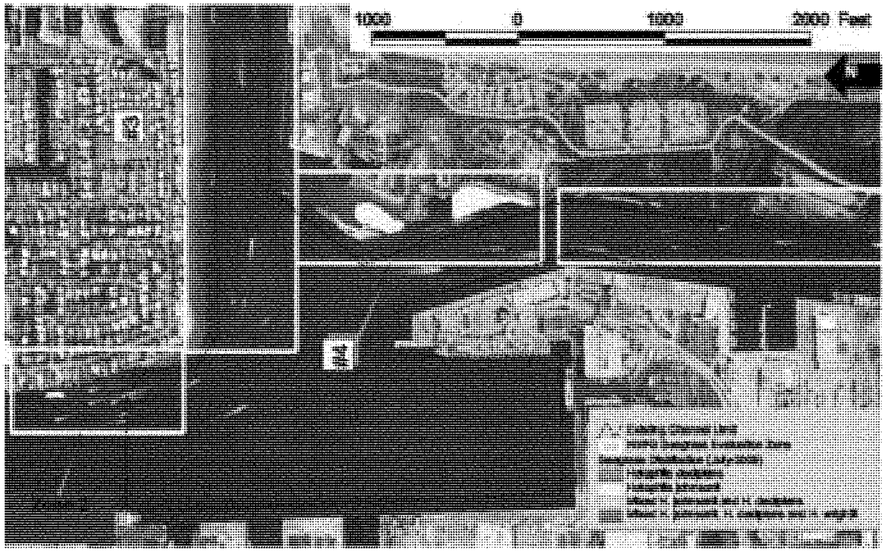


Figure 24 - Seagrass coverage in northern portion of project area

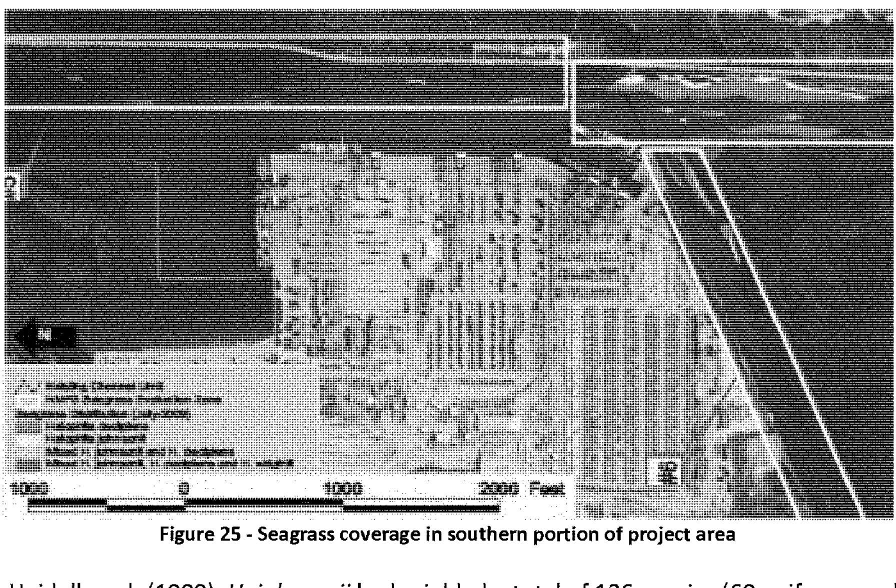


Figure 25 - Seagrass coverage in southern portion of project area

In Heidelbaugh (1999), *H. johnsonii* beds yielded a total of 126 species (69 epifauna and 57 infauna). Three hundred and twenty macrofaunal organisms were collected from *H. johnsonii* beds. NMFS has concluded that the conservation of *H. johnsonii* will not only maintain the diversity of the seagrass communities, but also the important biodiversity and biophysical characteristics of the entire ecosystem (NMFS 2007). Although *H. johnsonii* serves as hiding and resting area for many species, Gabiel and Hirons (2011), in a study specific to the project impact areas in the SAC, state "consumers in Port

Everglades are not feeding on seagrass" including some of the densest patches of *H. johnsonii* in the project area.

The total amount of *H. johnsonii* mapped in the project vicinity ranged between 1999-2009 from 4.81 acres to 5.40 acres with an average of 4.98 acres.

Table 3 - Mapped Johnson's seagrass in project vicinity

Bed Type (sp)	1999-2000 Acres	2005 Acres	2009 Acres	Average Acres coverage (minus DCC)
H. Johnsonii	2.85	2.80	4.68	3.44
Mixed *H. johnsonii/H. decipiens*	0.00	1.08	0.46	0.77
Mixed *H. johnsonii/H. decipiens/H. wrightii*	1.96	0.09	0.26	0.77
Totals	4.81	3.97	5.40	4.98

Critical Habitat

The northern and southern ranges of Johnson's seagrass are defined as Sebastian Inlet and central Biscayne Bay, respectively. These limits to the species' range have been designated as critical habitat for Johnson's seagrass. Within its range, Johnson's seagrass critical habitat designations have been designated for 10 areas: a portion of the Indian River Lagoon, north of the Sebastian Inlet Channel; a portion of the Indian River Lagoon, south of the Sebastian Inlet Channel; a portion of the Indian River Lagoon near the Fort Pierce Inlet; a portion of the Indian River Lagoon, north of the St. Lucie Inlet; a portion of Hobe Sound; a site on the south side of Jupiter Inlet; a site in central Lake Worth Lagoon; a site in Lake Worth Lagoon, Boynton Beach; a site in Lake Wyman, Boca Raton; and a portion of Biscayne Bay. There is no designated critical habitat within the action area (NMFS, 2000).

Invertebrates - Staghorn and Elkhorn Corals

Staghorn (*Acropora cervicornis*) and elkhorn (*Acropora palmata*) corals were listed as threatened under the ESA on May 9, 2006, (71 FR 26852) based on a status review completed by NMFS in March 2005 (70 FR13151). NMFS published a "4D" rule for these *Acropora* species on October 29, 2008 (73 FR 64264) providing a list of activities that would result in "take" as defined by the ESA. NMFS published a final rule to designate critical habitat for these species on November 26, 2008 (73 FR 72210). NOAA has not yet prepared a recovery plan for either *Acropora* species. However a recovery plan development team completed a draft and provided this to NMFS for revisions and publication.

The Atlantic *Acropora* Status Review presents a summary of published literature and other currently available scientific information regarding the biology and status of both elkhorn and staghorn corals (http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/corals.pdf).

Based on the status review and final critical habitat designation, NMFS has determined that any hardground habitat located in Florida south of Boyton Inlet in Palm Beach County in waters less than 30 meters deep has the potential to support either of the *Acropora* species (NMFS 2005). The final critical habitat determination identifies that the primary constituent elements for the continued survival of acroporid species may be found in waters less than 30 meters in depth (NMFS 2007).

In October 2007, NMFS released the revised *Interim Acropora Survey Protocol for Section 7 Consultation*, a protocol for surveys to be conducted for projects within the known habitat of *Acropora* sp. Corps staff met with NMFS leadership in April 2008 to discuss the applicability of this interim protocol in high traffic federal navigation channels where human safety was a major concern. NMFS-OPR leadership agreed that a modified methodology for surveying for *Acropora* in 13 federal navigation channels within *Acropora* critical habitat was warranted. Working under this agreement, Corps developed a two-tiered survey approach. The two-tiered method includes integrated towed video survey, with a built in altimeter, that would allow the flyer and viewer to know the distance to the bottom, follow-up ground-truthing diver surveys, and diver surveys following the NMFS protocol.

Corps has conducted a total of four surveys (one specifically for Acropora in 2010) of the proposed project area between 2001-2010 (Figure 26), using a combination of towed video and divers, and has not documented the presence of either species in the project area.

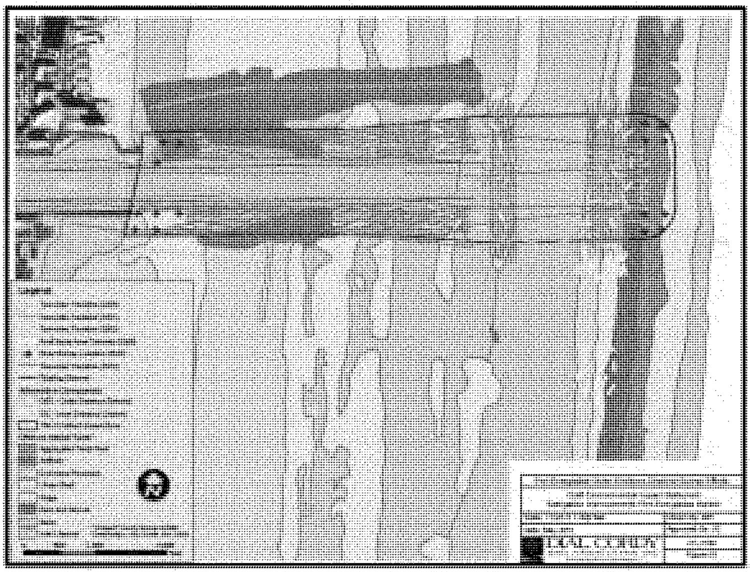


Figure 26 – Total Survey Coverage by Corps for Port Everglades 1999-2011

Towed video transects covered more than 40% of the entire direct and indirect impact area. This is significantly more area than would be covered if the diver-only protocol would have been employed to survey for *Acropora spp.* in the project area. Twenty-one dives were made to identify organisms that were designated as "potential" *Acropora* colonies in post-processed video. No *Acropora* colonies were documented within the direct or indirect impact areas of the Port Everglades expansion area during this survey. Full results of this survey are found in the "Port Everglades Feasibility Study *Acropora* Coral Survey Final Report October 2010" (Appendix 6). Additionally, the US Navy conducted a survey of coral species located within the South Florida Ocean Measurement Facility Restricted OPAREA located immediately south of the OEC (USN 2011/Appendix 5) (Figure 27).

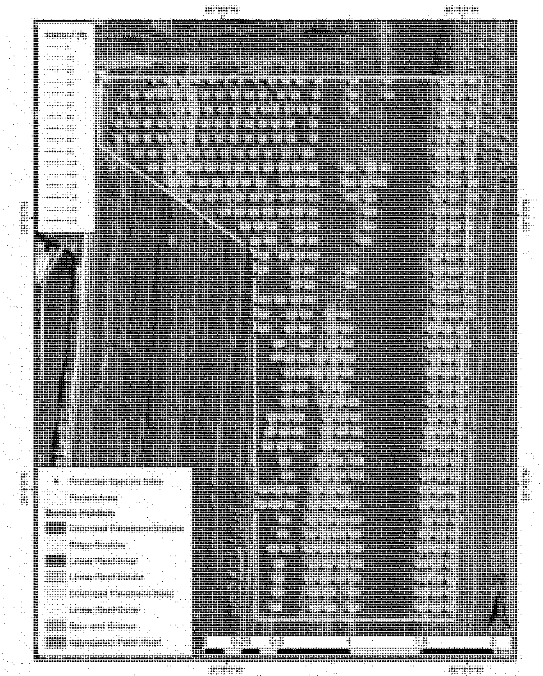


Figure 27 - US Navy Protected Coral Species Survey sample sites

A. cervicornis colonies are known to exist in the vicinity of Port Everglades, 2,780 feet (848m) to the south of the Port entrance channel, on the near shore hardbottom, and 1,400 feet (427m) north on the inner reef (Dial Cordy 2010, NOVA 2008). The Navy located *Acropora cervcornis* on the first, second and third reefs offshore of their facility located south of the OEC. *Acropora palmata* was not documented during the Navy survey. The closest documented *Acropora cerviconis* to the expansion project was located on the first reef, at the edge of the 150 meter (492 feet) buffer from the project footprint, approximately 500 feet south of the channel. This location is outside the indirect impact assessment area for the Port Everglades expansion project. Although the Navy survey did document *Acropora cervicornis* on the third reef, the closest documented colonies (1-5 colonies in density) were located more than a mile south of the 150-m project buffer (Figure 28). As of the writing of this document, no colonies of *A. palmata* have been documented within the vicinity of the existing channel. To-date, no *A. cervicornis* have been identified within the direct or indirect impact areas within the proposed Project area (Dial Cordy 2010, USN 2011).

Although *Acropora cervicornis* and *Acropora palmata* have not been located in the project footprint, or adjacent indirect impact zone, we recognize that this may change between the finalization of this consultation and initiation of construction dredging by the species migrating into the project footprint or that a colony less than 1-2 years old, not visible to the eye during the surveys (NMFS 2005) matures and becomes visible to the naked eye. As we have previously committed to in our letter dated October 18, 2006 and our October 13, 2006 Effects Determination Memorandum, if any *Acropora cervicornis* or *Acropora palmata* are located prior to or during project construction, the Corps will implement the protective measures detailed in the Terms and Conditions of the Miami Harbor September 2011 Biological Opinion (F/SER/2011/00029) reinitate consultation with NMFS under the ESA.

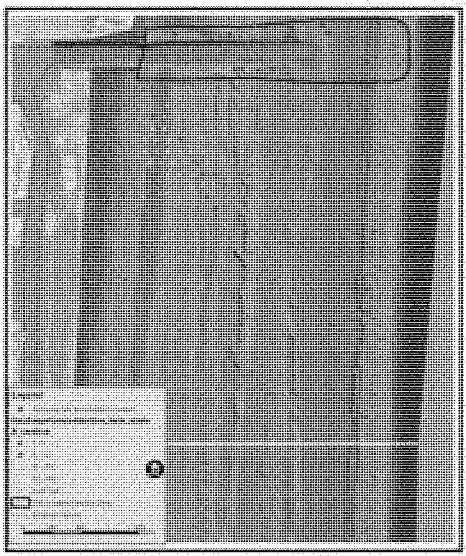


Figure 28 - Location of USN *A. cervicornis* colonies in comparison with Port Everglades Channel

Critical Habitat

On November 26, 2008, NMFS published a final rule in the Federal Register to designate critical habitat for Elkhorn and staghorn corals. Four specific areas were designated, including: the Florida unit (approximately 1,329 square miles of marine habitat); the Puerto Rico unit (approximately 1,383 square miles of marine habitat); the St. John/St. Thomas unit (approximately 121 square miles of marine habitat); and the St. Croix unit (approximately 126 square miles of marine habitat).

Designated critical habitat in the Florida Unit includes the Atlantic Ocean offshore of Broward County (Figure 29). Within these water depths, NMFS has defined that, "substrate of suitable quality and availability" is equivalent to consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover. (NMFS, 2008b). An area south of Port Everglades referred to as the "Dania RAA" was excluded from the DCH under 50 CFR §226.216(d). This area abuts the south side of the existing federal channel approximately 300 feet south of the channel, creating a 7.45 acre strip of DCH on the south side of the channel (Figure 30).

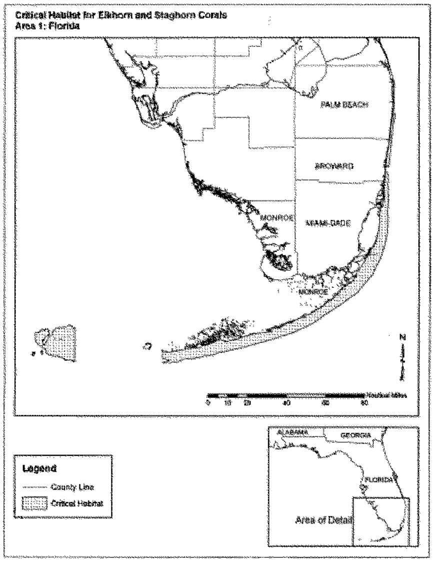


Figure 29 - Designated critical habitat for Elkhorn and staghorn corals in the Florida Area.

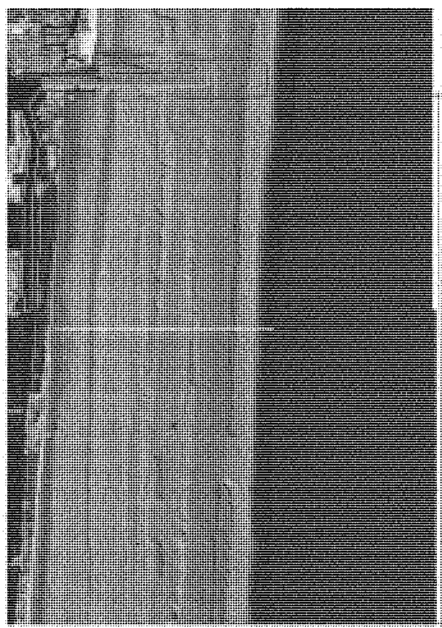


Figure 30 - Boundaries of Dania RAA in relation to Entrance Channel

Protective Measures to be taken in the Project Area as Part of the Proposed Action

Based on previous biological opinions issued by NMFS for adverse affects to listed *Acropora sp.*, Johnson's seagrass, smalltooth sawfish and sea turtles associated with dredging and construction, the Corps plans to incorporate "terms and conditions" from these opinions into the plans and specifications for the Port Everglades project. These efforts will include:

1. Smalltooth Sawfish/Sea Turtles - Incorporation of the NMFS "Sea Turtle and Smalltooth Sawfish Construction Conditions" into the project plans and specifications:

a) The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.

b) The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

c) Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

d) All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

e) If a sea turtle or smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

f) Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

g) Any special construction conditions, required of the project, outside these general conditions, if applicable, will be addressed in the primary consultation.

2. Acropora –
a) Transplantation of any Acroporid corals located during pre-construction surveys or during construction monitoring greater than 10 cm in size.
b) Turbidity monitoring during construction to meet the requirements in the Section 401 water quality certificate issued by the FLDEP.
c) Sedimentation monitoring during construction.
d) Maintaining a sufficient buffer from all mapped hardgrounds when placing rock for the reef mitigation creation site to ensure no damage occurs to those hardgrounds when placing the rock for artificial reef creation.

State of Florida

The State of Florida has numerous laws, regulations and programs aimed protecting corals and coral reef habitats, including those habitats that support Acroporid coral species. The Coral Reef Conservation Program (CRCP), as part of the Florida Department of Environmental Protection (FLDEP) coordinates research and monitoring, develops management strategies, and promotes partnerships to protect the coral reefs, hardbottom communities, and associated reef resources of southeast Florida. Through its role in supporting Florida's membership on the U.S. Coral Reef Task Force, and the U.S. All Islands Committee, the CRCP leads the implementation of the Southeast Florida Coral Reef Initiative and contributes to the National Action Plan to conserve coral reefs. The CRCP is also charged with coordinating response to vessel groundings and anchor damage incidents in southeast Florida, and developing strategies to prevent coral reef injuries. Florida Fish and Wildlife Conservation Commission's Wildlife Research Institute (FWRI) funds and conducts research activities on coral and hardbottom habitats throughout Florida, including those that support Acroporid corals and DCH.

Broward County

Broward County conducts numerous monitoring efforts throughout the county for all coral habitats, including Acroporid corals. They also deploy artificial reefs and maintain a mooring buoy program to establish a system of mooring buoys for recreational vessels to protect natural and artificial reefs from damage caused by boat anchors (http://www.broward.org/NATURALRESOURCES/BEACHANDMARINE/Pages/mooringbuoys.aspx). More than 120 buoys are available for use at various locations off Broward County. These sites include popular natural and artificial reef sites, including those habitats that may support Acroporid corals in Broward County. Broward County environmental staff also serves as the environmental assurance and compliance agent during county-sponsored in-water construction activities.

The Nature Conservancy
The Florida Reef Resilience Program brings scientists, reef managers and resource user groups together to develop strategies to improve the health of Florida's reefs and enhance the economic sustainability of reef-dependent commercial enterprises.

Scientific Research
NMFS provided an exception to the take prohibition for research and enhancement activities authorized by six (6) specific permit programs in the Acropora 4(d) Rule <http://sero.nmfs.noaa.gov/pr/pdf/AcroporaFinal4dRule.pdf> , they have not issued and permits under Section 10(a)(1) of the ESA to date (Jennifer Moore, pers.comm). Specifically for Broward County, any *Acropora* research would be permitted by the FWC. So long as a researcher holds a valid permit from FWC, no ESA sec 10 permit is required. NMFS may obtain a list of current permit holders from FWC as part of this consultation.

Other consultations of Federal actions in the action area to date

- None of the expansion projects authorized by Congress through 1968 were required to consult under the ESA. Port Everglades projects following implementation of the ESA are listed in the table below.

Date	Activity	Authorizing document/permit	Action	Volume of dredged material	Mitigation
1979-81	Port Expansion	H. Doc 93-144; 93rd Congress	Widening of entrance channel on a new alignment (shift centerline 75 ft north)	Not documented	Creating of Fishing Reef in SW Corning of "old" ODMDS in ~125 ft of water
1983	Berth 29 Bulkhead and Channel	USACE 81L-0624 FDER 060419139	Berth deepening and bulkhead construction	Dredge 311,000 cy material from unvegetated bottom	0.4 acres mangrove creation
1984	Pier 7 Channel Dredging	USACE 83D-2441 FDER 060257779	Channel deepening	Dredge 242,222 cy material from unvegetated bottom	None
1984	East Channel Dredging	USACE 84D-0385 FDER 060748269	Channel improvements	Dredge 46 acres unvegetated bottom, fill 4.73 acres of unvegetated bottom	None
1987	Construct Turning Notch	USACE 84R-4146 FDER 060924019	Port expansion	Removal of 18.27 acres of mangrove wetlands	Creation of 23 acres of mangroves, preservation of 48 acres of mangroves, creation of manatee refuge
1989	Construct Berth 33	USACE 84Y-4246 FDER 061407349	Port expansion	Removal of 2.0 acres of mangrove wetlands	Creation of 4.5 acres of mangroves
2004	Dredging of North Turning Basin		Operations and Maintenance Dredging	N/A	N/A
2005	Dredging of Entrance Channel		Operations and Maintenance Dredging – placement on JUL Beach as part of Broward SPP Seg III	Removed 40,523 cu yd of beach quality sand from inner entrance channel	N/A

2005-2006	Broward County Shore Protection Project, Segment 3	SAJ-1999-5545	Renourishment of Segment 3 of the Broward SPP from Beach fill extended from FDEP R-86 to R-92 within John U. Lloyd State Park, and R-99 to R-128 (Dade County line).	Burial of 7.6 acres of nearshore hardbottom (direct burial of 0.9 acres in John U. Lloyd State Park and 1.1 acres of worm rock habitat in Hollywood).	FDEP required the placement of 8.9 acres of mitigative artificial reef.

- The Corps and Broward County are currently in the planning process for a renourishment of Segment II of the Broward County Shore Protection Project located north of the port. ESA Consultation has not yet been initiated for that effort.
- Regulatory permits issued by the Jacksonville District's West Palm Beach Field Office under Section 10 of the Rivers and Harbors Act and/or Section 404 of the Clean Water Act are required to undergo consultation under Section 7 of the ESA. NMFS-PRD should have these consultations detailed in the PCTS tracking system for analysis.

Effects of the Action

Larger Vessels calling in the Future – All Species

Vessel Calls in a Without Project Condition

A major area of concern raised by resource managers is the increase in vessels expected to arrive as a result of the expansion of Port Everglades. The economic analysis of the project's without-project condition show as many as 8,984 vessels will be calling annually at Port Everglades, an increase from the pre-2009 baseline of more than 3,691 vessels (Table 4). This increase in vessel calls associated with the "Future without project" scenario/ No-Action Alternative will result in increased pressure on berth capacity as more ships arrive at the port and the port does not have more berthing capacity to absorb them. This will result in more ships waiting in the anchorage for berths to open and as a result may result in a greater likelihood of anchor damage or of a ship breaking free of the anchorage and grounding on the reefs shoreward of the anchorage. In a report about the usage of the Port Everglades Anchorage, Moffatt and Nichol (Moffat and Nichol 2006) documented that 50% of the grounding and anchorage damage was linked to vessels awaiting berths to open in Port Everglades. Although this report was specific to the old anchorage that was reconfigured to reduce impacts to the inshore reefs, as more vessels are crowded into the new anchorage, the potential for adverse impacts increases.

Table 4 - Baseline and Future Without Project Vessel Calls

Vessel Type	Baseline - Pre 2009			Future W/o Project 2009-2067				
	Baseline (High # Calls pre-2009)	Year	Passengers/tons	Future Calls w/o project	Projection Year	Passengers/tons	Change from base	Percentage change from base
Liquid bulk (minus Aframax)	467	2008		532	2066		65	12%
Aframax tanker	3	2008		3	2067		0	0%
Container								
PP2 = Post-Panamax 2 vessel size.	0	2008		103	2066		103	100%
PP1 = Post Panamax 1 vessel size.	23	2008		356	2066		333	94%
PEW= Panamax East West services.	117	2008		173	2066		56	32%
PNS = Panamax North South services.	190	2008		537	2066		347	65%
SP = Sub-Panamax size.	89	2008		187	2056		98	52%
Handy = Handysize.	491	2008		1388	2066		897	65%
Feedermax = Feedermax size.	235	2008		573	2066		330	59%
Feeder = Feeder size.	583	2008		1224	2056		641	52%
General Cargo	135	2006		176	2067		41	23%
RoRo	537	2006		1361	2067		824	61%
Cruise	2297	2004	4,075,406	2069	2067	6,879,729	-228	-11%
Dry Bulk	126	2006	2,954,310	302	2066	7,371,749	176	58%
	5293			8984			3691	

The Cruise industry has already launched two newer, larger classes of cruise ship since the economic and ship simulation analysis was completed by the Corps. When the Corps did the analysis for the project, the *Voyager of the Seas* (Voyager Class), launched in 1999, was the largest cruise ship in the world with a length of 1,020 ft, a beam (width) of 156 ft, a draft of 28 ft and a sail area (area above the water line) of 207 feet. In 2006, The *Freedom of the Seas* (Freedom Class) became the largest cruise ship in the world, with a length of 1,111 ft, a beam of 126 feet, a draft of 28 feet and a sail area of 209 feet. Currently, the *Oasis* and *Allure of Seas*, launched in December 2010 and October 2010, respectively, have a length of 1,187 feet, a beam of 154 feet, a draft of 31 feet and a sail area of 236 feet and are the largest cruise ships in the world. Both of these ships sail from Port Everglades.

Lastly, as larger ships call at Port Everglades, albeit light loaded and/or with higher sail area, they lack sufficient room in the outer entrance channel to respond to wind and varying current conditions in the channel, resulting in a higher risk of grounding on the reefs adjacent to the channel or scraping against the walls of the outer channel (allusion), impacting the resources that have colonized the walls since the channel was widened in 1980. This would also result in a higher likelihood of oil spills associated with vessels grounding (particularly petroleum vessels) and thus endanger human health and safety, in addition to the surrounding environment.

<u>Vessel Calls with Project Conditions</u>
Under the "with project" condition, the number of vessels calling at Port Everglades from all vessel classes is not expected to change significantly in association with the

additional depth. Growth projections showed increase use of the port with or without the deepening project, however, the amount of cargo and liquid bulk on the vessels is expected to increase as the vessels add more cargo in response to the additional water depth available for use, allowing for more efficient use of the vessels. The future without the project in 2067 estimates 8,984 vessel calls, an increase of 3,691 vessel calls into Port Everglades. With project vessel calls in 2067 are estimated to be 8,693, one call less than estimated without the project. Additionally, newer generations of cruise ships will add more passengers as the ships get larger. The project allows for a shift from smaller, less efficient ships, to larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls, or possibly decreasing the number of vessel calls, which is consistent with national trends detailed in IWR 2012 and Figure 31. Table 5 provides a summary of historic and projected future vessel calls.

Table 1: Forecast East Coast Container Fleet 2012-2035

	2012	2015	2020	2025	2030	2035
0.1 - 1.3 k TEU	24	11				
1.3 - 2.9 k TEU	34	12	6	4	3	3
2.9 - 3.9 k TEU	28	12	10	4	4	2
3.9 - 5.2 k TEU	140	95	78	58	42	29
5.2 - 7.6 k TEU	86	114	153	156	159	168
7.6 - 12.0 k TEU	26	61	96	155	227	322
12.0 k TEU +		3	13	42	82	136

Note: post-Panamax vessel bands shaded in yellow. Source: Maritime Strategies International, Limited

This East Coast container fleet forecast shows the number of container vessels (by TEU range) being deployed on trade routes that include the U.S. East Coast ports. Vessels above 52k TEU are considered post-Panamax vessels.

Figure 31 - Shift from panamax to post-panamax ship class between 2012 and 2035 (IWR 2012)

Table 5 - Vessel Call Projects, Baseline, Future Without and Future With Project

With and Without Project Vessel Calls

		Baseline - Pre 2009			Future W/o Project 2009-2067					Future With Project 2009-2067					
Feasibility Study table	Vessel Type	Baseline (High # Calls pre-2009)	Year	Passengers/tons	Future Calls w/o project	Projection Year	Passengers/tons	Change from base	Percentage change from base	Future Calls w/ project	Projection Year	Passengers/tons	Change from base	Percentage change from base	Difference w vs wo project
4-33	Liquid bulk (minus Aframax)	467	2008		532	2066		65	12%	532	2066		65	12%	0
4-33	Aframax tanker	3	2008		3	2067		0	0%	2	2067		-1	-50%	-1
	Container														
7-1/S-11	PP2 = Post-Panamax 2 vessel size.	0	2008		103	2066		103	100%	103	2066		103	100%	0
7-1/S-9	PP1 = Post-Panamax 1 vessel size.	23	2008		356	2066		333	94%	356	2066		333	94%	0
7-1/S-7	PEW= Panamax East West services.	117	2008		173	2066		56	32%	173	2066		56	32%	0
7-1	PNS = Panamax North South services.	190	2008		537	2066		347	65%	537	2066		347	65%	0
7-1	SP = Sub-Panamax size.	89	2008		137	2066		48	52%	137	2066		48	52%	0
7-1	Handy = Handysize.	491	2008		1388	2066		897	65%	1388	2066		897	65%	0
7-1	Feedermax = Feedermax size.	235	2008		573	2066		338	59%	573	2066		338	59%	0
7-1	Feeder = Feeder size.	583	2008		1224	2066		641	52%	1224	2066		641	52%	0
4-35	General Cargo	135	2006		176	2067		41	23%	176	2067		41	23%	0
4-36	RoRo	537	2008		1361	2067		824	61%	1361	2067		824	61%	0
4-37	Cruise	2297	2003	4,075,406	2069	2067	6,879,729	-228	-11%	2069	2067	6,879,729	-228	-11%	0
4-34	Dry Bulk	126	2006	2,954,330	302	2066	7,371,749	176	58%	302	2066	7,371,749	176	58%	0
		5293			8984			3691		8983			3690		

As a result of this analysis, there is no affect to any listed species under NMFS jurisdiction, associated with deepening of the harbor with regard to larger ship arrival as the number and sizes of ships arriving after project implementation is expected to remain the same, or possibly decrease, due to the ability for ships to be fully loaded in the "with project" condition. The extension and deepening of the outer entrance channel is expected to improve safety and navigability, reducing the potential for ship groundings and subsequent oil spills, both of which would result in adverse impacts to all species under NMFS jurisdiction in the action area.

Johnson's Seagrass

Effects from Dredging.

Dredging would result in the permanent removal of up to approximately 3.57 acres of mixed or monoculture Johnson's seagrass where it occurs along the SAC and Widener based on the maximum coverage of Johnson's seagrass seen in the 1999-2009 seagrass surveys. Average cover of *H. johnsonii* during this same period of time was 2.71 acres. The impact is considered permanent because deepening of shallow-water habitats beyond 10 to 13 feet (3 to 4 meters) is likely to impede post-dredging recolonization of areas that currently support *H. johnsonii* (NMFS 2007, Kenworthy 2000, and Hammerstrom *et al*. 2006). This effect would be seen throughout the improved Widener and SAC, where water depths will be at to 50 feet MLLW plus 1 foot of required overdepth and 1 foot of allowable overdepth for a total dredge depth of up to 52 ft MLLW. Due to implementation of water-quality-protection Best Management Practices (BMPs) and turbidity monitoring required under FDEP permit, Corps does not anticipate indirect effects to seagrasses including Johnson's seagrass outside the impact footprint. Although seagrass habitat creation in Westlake Park as mitigation for unavoidable impacts, is being proposed, impacts to ESA species/resources cannot be mitigated, and there is no guarantee that *H. johnsonii* will colonize the mitigation area (as opposed to *H. decipiens* or *Halodule wrightii*). NMFS has listed *H. johnsonii* as a threatened species under Section 4 of the ESA, to date, it has not promulgated a 4d rule under the Act, and as a result, there is no prohibition on take of *H. johnsonii.* There is no critical habitat for *H. johnsonii* in the project area.

Smalltooth Sawfish

Effects from Dredging.

Although 16 sightings of sawfish have been made within the boundaries of Broward County, the likelihood of sawfish being in the project area is minimal, as the Port does not provide optimal habitat for sawfish (Simpendorfer 2006). The proposed deepening activities using a cutterhead, clamshell or hopper dredge are not expected to affect the sawfish (NMFS 2003b, as amended).

The assumptions and conclusions regarding cutterhead (pipeline) and mechanical (clamshell) dredges in the 1991, 1995 and 1997 South Atlantic Regional Biological Opinions (SARBO) and 2003 (as amended) Gulf Regional Biological Opinion (GRBO) (NMFS, 1991; NMFS 1995; NMFS 1997; and NMFS 2003) for sea turtles apply to sawfish as well. The 1991 SARBO states:

> "Clamshell dredges are the least likely to adversely affect sea turtles because they are stationary and impact very small areas at a given time. Any sea turtle injured or killed by a clamshell dredge would have to be directly beneath the bucket. The chances of such an occurrence are extremely low, although a take of a live turtle by a clamshell dredge has been documented at Canaveral. On the basis of the best available information, NMFS has determined that dredging with a clamshell dredge is unlikely to result in the take of sea turtles."

> "...pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have approach the cutterhead and be caught in the suction. This type of behavior would appear unlikely, but may be possible. Presently, NMFS has determined that pipeline dredges are unlikely to adversely affect sea turtles."

The 2003 GRBO states...

> "In contrast to hopper dredges, pipeline dredges are relatively stationary, and therefore act on only small areas at any given time. In the 1980s, observer coverage was required by NOAA Fisheries at pipeline outflows during several dredging projects deploying pipeline dredges along the Atlantic coast. No turtles or turtle parts were observed in the outflow areas. Additionally, the COE's South Atlantic Division (SAD) office in Atlanta, Georgia, charged with overseeing the work of the individual COE Districts along the Eastern Seaboard from North Carolina through Florida, provided documentation of hundreds of hours of informal observation by COE inspectors during which no takes of listed species were observed. Additional monitoring by other agency personnel, conservation organizations, and the general public has never resulted in reports of turtle takes by pipeline dredges."

Corps concludes that if this statement holds true for species that are relatively abundant in South Florida like sea turtles, it should also hold true for a very rare species like sawfish.

In the 2003 GRBO, NMFS made the following determination

> "After consultation with individuals with many years in the business of providing qualified observers to the hopper dredge industry to monitor incoming dredged material for endangered species remains (C. Slay, Coastwise Consulting, pers. comm. August 18, 2003) and a review of the available scientific literature, NOAA Fisheries has determined that there has never been a reported take of a smalltooth sawfish by a hopper dredge, and such take is unlikely to occur because of smalltooth sawfishes affinity for shallow, estuarine systems."

The probability of a sawfish being taken by a cutterhead, mechanical or hopper dredge is so unlikely as to be discountable. To help minimize the potential for sawfish take, the Corps will incorporate the NMFS sawfish protection construction protocols into the plans and specifications. All depth alternatives would result in the same impact to smalltooth sawfish as discussed for the TSP.

Based on the information included in the recovery plan, the census information from FWC and NMFS and the proposed construction techniques, Corps determined that the expansion of Port Everglades using a cutterhead, clamshell or hopper dredge may affect, but is not likely to adversely affect the endangered smalltooth sawfish.

NMFS also came to this determination in the recently completed Biological Opinion for Miami Harbor (F/SER/2011/00029) stating:

> "NMFS has identified the following potential effects to smalltooth sawfish and has concluded that sawfish are not likely to be adversely affected by the proposed action. Effects on sawfish include the risk of injury from dredging activities, although there has never been a reported take of a smalltooth sawfish by any type of dredge. Smalltooth sawfish may be affected by being temporarily unable to use the site due to potential avoidance of construction activities and related noise, and physical exclusion from areas contained by turbidity curtains, but these effects will be insignificant. Disturbance from construction activities and related noise will be intermittent and only for part of the construction period; turbidity curtains will only enclose small areas at any one time in the project area, will be removed upon project completion, and will not appreciably interfere with use of the area by sawfish. Due to the species' mobility and the implementation of NMFS' Sea Turtle and Smalltooth Sawfish Construction Conditions, the risk of injury will be discountable."

Effects of Blasting.
Review of ichthyological information and test blast data indicates that fishes with swim bladders are more susceptible to damage from blasts, and some less-tolerant individuals may be killed within 140 feet of a confined blast (USACE 2000). Sawfishes, as chondrichthyans, do not have air bladders, and, therefore, they would be more tolerant of blast overpressures closer to the discharge, possibly even within 70 feet of a blast (Keevin and Hempen 1997). Based on this information, and the rarity of the species in the project footprint, the Corps believes that impacts to sawfish associated with blasting will be minor and discountable.

NMFS also came to this determination in the recently completed Biological Opinion for Miami Harbor (F/SER/2011/00029) stating "Therefore, NMFS believes that the effects on sawfish from blasting will be insignificant."

Indirect Effects on Habitat.
Although seagrass and other soft bottom habitats will be removed, Corps does not anticipate that the proposed project will have any adverse indirect effects on smalltooth sawfish in the vicinity of the action area. These habitats may be utilized by the species, however, loss of seagrass habitats is relatively small with respect to overall seagrass abundance throughout the area, and will be compensated through mitigative measures that have already begun to show increases in seagrass coverage in West Lake Park associated with the first phases of restoration efforts (Dylan Larson, pers comm., August 2011). Nearshore softbottom areas are also plentiful in and near the action area, and impacts to them would not limit resource use by sawfish, especially since population density of individuals in the area is extremely low. Construction of gaps in the rip-rap as part of the environmentally friendly bulkheads along the SAC and TN will ensure that juvenile sawfish, will have access to the existing mangroves on the western shoreline of JUL and the western side of the SAC some of which currently have no access due to the height of the rip-rap along the front of the mangroves, as well as any new mangroves that colonize the shoreline behind the EFBs, which would increase available mangrove habitat.

Sea Turtles
Since beaches of JUL provide important nesting areas for four sea turtle species and the offshore areas provide foraging ground for five listed sea turtle species, the project area comprises important resources for turtles. The project allows for a shift from smaller, less efficient ships, to larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls, or even resulting in a decrease in overall vessel calls. Due to the widening and deepening components of the project, larger container, petroleum, bulk cargo and cruise vessels will call at Port Everglades and more tonnage will be carried per vessel call. The widened and deepened channels may provide sea turtles more room to maneuver around incoming and outgoing vessels throughout the action area, and avoid vessel strikes. Dredge activities and associated disturbances (noise, lights, etc.) offshore may interrupt the movement of turtles swimming toward or away from nesting beaches.

Free-swimming turtles.
If a hopper dredge is utilized to clear shoaling material from the top of rock prior to dredging the rock within Port Everglades, Corps will comply will all terms and conditions for the use of hopper dredges in the Biological Opinion for this project to assure that incidental take of sea turtles are minimized during hopper dredging operations. A rigid-draghead designed to deflect sea turtles is required for all hopper-dredging projects throughout the year in South Florida, due to the year-round presence of sea turtles. The South Atlantic Regional Biological Opinion (NMFS 1997) mandates that year round, 100 percent observer coverage on the hopper dredge by NMFS-approved Endangered Species Observers is required for the Port Everglades project, if a hopper dredge is used during project construction. One-hundred percent inflow screening is required, and 100 percent overflow screening is recommended. If conditions prevent one hundred percent inflow screening, inflow screening can be reduced, but 100 percent outflow screening is required, and an explanation must be included in the preliminary dredging report. Preliminary dredging reports which summarize the results of the dredging and any sea turtle take must be submitted within 30 working days of completion of any given dredging project. Logs of any sea turtle injuries or deaths due to hopper dredging activities will be maintained, with immediate notification by the contractor to Corps-Jacksonville District, and NMFS. NMFS has previously determined (NMFS 1991, 1995, 1997 and 2003 as amended that pipeline and clamshell dredges are not likely to take sea turtles (NMFS, 1991):

> "Clamshell dredges are the least likely to adversely affect sea turtles because they are stationary and impact very small areas at a given time. Any sea turtle injured or killed by a clamshell dredge would have to be directly beneath the bucket. The chances of such an occurrence are extremely low, although a take of a live turtle by a clamshell dredge has been documented at Canaveral. On the basis of the best available information, NMFS has determined that dredging with a clamshell dredge is unlikely to result in the take of sea turtles."
>
> "...pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have approach the cutterhead and be caught

> in the suction. This type of behavior would appear unlikely, but may be possible. Presently, NMFS has determined that pipeline dredges are unlikely to adversely affect sea turtles."

A hopper dredge was previously used in the entrance channel and inner portions of the Port in 2005 for two separate dredging events. A total of 200 loads over a three-month period resulted in no documented lethal or injurious take of sea turtles during dredging operations. The following websites provide useful data:

- http://el.erdc.usace.army.mil/seaturtles/project.cfm?Id=442&Code=Project
- http://el.erdc.usace.army.mil/seaturtles/project.cfm?Id=403&Code=Project

As part of the standard plans and specifications for the project, Corps has agreed to implement the NMFS "Sea Turtle and Smalltooth Sawfish Construction Conditions," as detailed above in the section discussing sawfish. Additionally, the Corps will include all terms and conditions from the SARBO (1997) regarding vessel lighting and sea turtles, including the following:

> "From May 1 through October 31, sea turtles nesting and emergence season, all lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nm of sea turtle nesting beaches shall be limited to the minimal lighting necessary to comply with U.S. Coast Guard and/or OSHA requirements. All non-essential lighting on the dredge and pumpout barge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to minimize illumination of the water to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches."

As part of this effort, the Corps conducts lighting surveys of the contractor's dredges when they arrive on site, and require the contractor to meet all USCG and/or OSHA requirements. This process will be adhered to for the Port Everglades project. As previously stated by USFWS in their Fish and Wildlife Coordination Act Report, the Port is an active facility, offshore lighting is not an unusual feature of the area, and should not appreciably change the ambient conditions for free-swimming turtles in the vicinity of the project. In addition, all construction/dredging vessels are required to adhere to best management practices, such as preventing lights from exposure to shore through use of shields. Therefore, no adverse indirect impacts to free swimming sea turtles due to lighting associated with dredging operations are anticipated for the proposed project.

The highest potential impact to sea turtles may be the use of explosives to remove areas of rock within the Port. It has been documented that the pressure and noise associated with unconfined blasting can physically damage sensory mechanisms and other physiological functions of individual sea turtles (Keevin and Hempen 1997). Impacts associated with blasting can be broken into two categories: direct impacts and indirect impacts.

Direct Impacts.

To-date, there has not been a single comprehensive study to determine the effects of underwater explosions on reptiles that defines the relationship between distance/pressure and mortality or damage (Keevin and Hempen 1997). However, there have been studies, which demonstrate that sea turtles are killed and injured by underwater explosions (Keevin and Hempen 1997). Sea turtles with untreated internal injuries would have increased vulnerability to predators and disease. Nervous system damage was cited as a possible impact to sea turtles caused by blasting (U.S. Department of Navy 1998 as cited in USACE 2000). Damage of the nervous system could kill sea turtles through disorientation and subsequent drowning. The Navy's review of previous studies suggested that rigid masses such as bone (or carapace and plastron) could protect tissues beneath them; however, there are no observations available to determine whether the turtle shells would indeed afford such protection. Studies conducted by Klima *et al.* (1988) evaluated unconfined blasts of only approximately 42 pounds on sea turtles (four ridleys and four loggerheads) placed in surface cages at varying distances from the explosion. Christian and Gaspin's (1974) estimates of safety zones for swimmers found that, beyond a cavitation area, waves reflected off a surface have reduced pressure pulses; therefore, an animal at shallow depths would be exposed to a reduced impulse. This finding, which considered only very small-unconfined explosive weights, implies that the turtles in the Klima *et al.* (1988) study would be under reduced effects of the shock wave. Despite this possible lowered level of impact, five of eight turtles were rendered unconscious at distances of 229 to 915 meters from the detonation site. Unconscious sea turtles that are not detected, removed and rehabilitated likely have low survival rates. For CU blasting, these types of effects would not have occurred, due to the significantly reduced pressures associated with CU blasting. The proposed action will use CU blasts, which will significantly reduce the pressure wave strength and thus area around the discharge where injury or death may occur (Hempen *et al.* 2007). The Corps assumes that tolerance of turtles to blast overpressures is approximately equal to that of marine mammals (Department of the Navy 1998 in USACE 2000), *i.e.*, death would not occur to individuals farther than 400 feet from a confined blast (Konya 2001).

For assessing impacts of blasting operations on sea turtles, Corps relied on the previous analysis conducted by NMFS-OPR as part of their ESA consultations on the Miami Harbor GRR [NMFS Consult # F/SER/2002/01094] (NMFS 2003a); Miami Harbor Phase II project [NMFS Consult #I/SER/2002/00178] (NMFS 2002) as well as the results from the blasting conducted at Miami, where 16 sea turtles were recorded being in the action area during the 38-days when blasting occurred, without a single stranding of an injured or dead turtle being reported (Trish Adams, FWS pers.com, 2005; Wendy Teas, NMFS, pers.com 2005; Jordan *et al.* 2007). In both of the ESA Consultations for the two projects in Miami, with regard to impacts to sea turtles, NMFS found that, "NOAA Fisheries believes that the use of the mitigative measures above in combination with stemming the hole the explosives are placed in (which will greatly reduce the explosive energy released into the water column) will reduce the proposed action's effects on sea turtles to insignificant levels." (NMFS 2003a and 2002).

Pressure data collected during the Miami Harbor project in 2005 by Corps geophysicists and biologists showed that using the four zones previously described, the pressures associated with the blasts return to background levels (1-2 psi) at the margin of the danger zone. This means that any animal located inside the exclusion zone, but outside the danger zone would not be exposed to any additional pressure effects from a confined blast (Hempen *et al.* 2007).

Indirect Effects due to Construction.
Indirect impacts on sea turtles due to dredging/blasting and construction activities in the project area include alteration of behavior. For example, daily movements of sea turtles may be impeded or altered. Based on the protective measures proposed for this project, in concert with the reduction in pressure from the blast due to the confinement of the pressure in the substrate, the impacts to sea turtles associated with blasting should be minimal.

Indirect Effects due to Removal of/Damage to Resting/Foraging Habitat.
Removal of approximately 16.64 acres of middle and outer reef associated with the project entrance channel expansion will remove foraging habitat for any of the five sea turtle species known to be in Broward County. Based on a GIS analysis of habitat types (Walker *et al.* 2007), the project will remove 0.08% of the middle reef (shallow colonized pavement & linear reef middle tract) and 0.54% of the outer reef (deep colonized pavement; linear reef outer tract; spur & groove reef) foraging habitat within Broward County by expansion of the outer entrance channel (Figure 32 and Table 6). Although Walker's minimum mapping unit was limited to the 1-acre level, and the project impacts are assessed at a more detailed level, a more detailed assessment of all the impact categories throughout all of Broward County is not likely to change the results significantly. The removal percentages would also decrease significantly if the calculations included existing middle and outer reef habitats in the adjacent counties of Miami-Dade and Palm Beach available for sea turtle foraging. Removal of this habitat, while small in the overall county-wide assessment of available foraging habitat, will permanently remove this habitat from the project area, and while mitigation is planned to be provided for the reef impacts, there is no guarantee that sea turtles in the project area will be able to utilize that mitigation as foraging habitat.

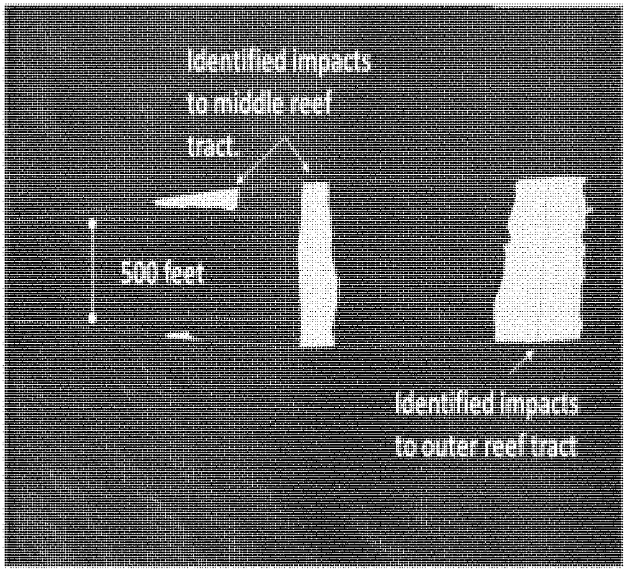


Figure 32 - Direct removal of sea turtle foraging habitat

Foraging habitats may also suffer some indirect effects, including temporary increases to turbidity and sedimentation on foraging habitat within the indirect impact zone for the project (the area within 150 meters surrounding the impact footprint). However, implementation of BMPs should reduce potential impacts, and they are not expected to be any greater than the effects of sedimentation and turbidity commonly experienced in this area due to the passage of storms (Pennekamp *et al.* 1996).

Table 6 - Relative Amount of Permanent Foraging Habitat Removal for Sea Turtles Due to Proposed Plan

Position and Habitat	Parameter	Coverage (ac)	Proportion (%)
Middle reef tract: shallow colonized pavement and linear reef habitats	Projected direct impact	5.56	
	Total available in Broward County	6,383	
	Relative impact		0.087
Outer reef tract: deep colonized pavement, linear reef, and spur and groove habitats	Projected direct impact	10.65	
	Total available in Broward County	1,958	
	Relative impact		0.54

Note: Acreage totals based on Walker *et al.* 2007 data

Direct Effects of each Construction Method on Acropora Critical Habitat

As previously stated, to date, colonies of *Acropora cervicornis* and *Acropora palmata* have not been located in either the direct or indirect impact areas of the project. Although *Acropora cervicornis* and *Acropora palmata* have not been located in the project footprint, or adjacent indirect impact zone, we recognize that this may change between the finalization of this consultation and initiation of construction dredging by the species migrating into the project footprint or that a colony less than 1-2 years old, not visible to the eye during the surveys (NMFS 2005) matures and becomes visible to the naked eye. As we have previously committed to in our letter dated October 18, 2006 and our October 13, 2006 Effects Determination Memorandum, if any *Acropora cervironis* or *Acropora palmata* are located prior to or during project construction, the Corps will implement the protective measures detailed in the Terms and Conditions of the Miami Harbor September 2011 Biological Opinion (F/SER/2011/00029) reinitiate consultation with NMFS under the ESA.

Dredging of the Channel Extension and Flare (All Dredge Types) - Direct Removal of Habitat by any Dredging Methodology

The most significant impact associated with dredging the entrance channel extension is the permanent removal of approximately 5.56 acres of the middle reef and approximately 10.65 acres of the outer reef to create the entrance channel flare as identified as a need for vessel safety. This flare is required due to the variable and unpredictable cross currents that are a result of eddies spinning off of the Gulf Stream located just offshore of the entrance channel as documented by Martinez-Pedraja, *et al.* (2004) and NOS (2010: Coast Pilot). Due to the increased size of the ships currently arriving at the port and the expected continuation of these larger ships to continue to arrive in the future, these cross currents can prove extremely unpredictable and may cause the ship to run aground on either side of the entrance channel. The Draft Feasibility Report for Port Everglades addresses existing issues with safe vessel navigation through the entrance channel due to unpredictable currents and documents. USCG casualty data dating from 1998- 2008 contained 55 casualties in and around Port Everglades due to vessel collisions, allisions or groundings. As a result of these groundings and ship simulations conducted by the Corps in support of the Feasibility study identifies extending the channel seaward 2,200 feet and creating an 800-ft wide mouth of the entrance channel to lessen the likelihood of vessel grounds as a result of these currents.

The DCH requires the presence of "substrate of suitable quality and availability" is equivalent to consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover as a "Primary Constituent Element" (PCE) that must be present for the physical area to be considered DCH. NMFS has not published a standard protocol for assessing the amount of "substrate of suitable quality and availability" to assess the presence of this PCE.

The proposed project's OEC component will permanently remove approximately 5.56 acres of the middle reef and approximately 10.65 acres of the outer reef to extend the entrance channel and create the flare. There are five hardbottom habitat types found in and adjacent to the existing federal channel and proposed extension and flare (based on Walker *et al.* 2007) that may be classified as designated critical habitat for acroporid species under the ESA:

- Shallow colonized pavement
- Deep colonized pavement
- Linear reef: middle tract
- Linear reef: outer tract
- Spur and groove reef: outer tract

The 5.56 acres of middle reef noted above equates to 0.0225 sq km of middle reef habitat and 10.65 acres of outer reef equates to 0.04310 sq km of outer reef habitat. The Florida unit of DCH is 3,442 sq km in size, adding the two impact figures together (0.0656 sq km) and dividing the impact area by the DCH area results in a determination that 0.00190587 % of DCH in the Florida unit will be permanently removed by the channel extension and widening (Table 7). This percentage assumes that 100% of the substrate is available for colonization, as NMFS defines it in the final rule designating critical habitat, ''substrate of suitable quality and availability'' meant consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover" (73 FR 72210 – 11/26/2008).

Table 7 - Direct Removal Impact of Designated Acropora Critical Habitat

Habitat type	Acreage/ km	%DCH of Florida unit removed by project – 100% clean substrate available	%DCH of Florida unit removed by project – % clean substrate survey results
Middle reef	5.56 ac (0.0225 sq km)	0.00065369%	0.00028762% (44% "available" substrate)
Outer Reef	10.65 ac (0.0431 sq km)	0.00125218%	0.00033809% (27% "available" substrate)
"Florida Unit" of DCH	3,442 sq km	0.00190587 % (0.0656 sq km)	0.00062571% (0.0215 sq km)

However, data show that there is 56% biotic coverage on middle reef (45% turf algae) and 73% biotic coverage on outer reef (55% turf algae) (DCA 2009) (Table 8).

Table 8- Percent cover of functional group categories as recorded in video belt transects at Port Everglades in 2006 (DCA, 2009)

Reef 2	*Zone 1*	*Zone 2*	*Zone 3*	*Avg*
Turf Algae	59.30	31.09	n/a	45.20
Sediment	16.92	38.60	n/a	27.76
Rubble	12.99	18.50	n/a	15.75
Reef 3	*Zone 1*	*Zone 2*	*Zone 3*	*Avg*
Turf Algae	60.93	52.37	50.56	54.62
Sediment	12.29	27.24	27.88	22.47
Rubble	6.37	2.15	4.34	4.29

This means that a maximum of 44% of the middle reef may be available for settlement of Acropid larvae and 27% of the outer reef may also be available. Calculating the percentages of available habitat, as defined by NMFS, 0.00062571% (0.0215 sq km) of the Florida unit of designated critical habitat available for colonization by Acropid larvae would be permanently removed by the project (Table 7).

Deepening of the entrance channel and dredging the flare is not expected to adversely impact any biological functions of acroporid corals (feeding, breeding, settling, etc). Concern has been expressed that deepening the existing channel and dredging the flare in the third reef may create a "sink" that fragments of acroporid corals could fall into and not escape, thus creating a physical blockage to fragments of acroporid corals moving north with the currents, thus hindering reproduction. The Corps has reviewed the available information on *Acropora sp.* coverage throughout south Florida, with specific attention paid to known colonies of *Acropora sp.* in the vicinity of deep water entrance channels.

The Corps has been unable to discover any research studies, monitoring reports or other publications that discuss this issue in any detail specific to *Acropora* species. There are 13 deepdraft navigation channels; three of which are currently slated to be deepened in the next 2-10 years; located within DCH, and this issue was not identified in the pending draft Recovery Plan for *Acropora* (in press) (that Corps reviewed as part of the recovery plan development team) as a potential hindrance to species recovery. The Corps was able to determine that there are two deepwater entrance channels within 25 miles of each other within DCH for acroporid corals: Miami Harbor and Port Everglades, both of which have been dredged to 45 feet. Miami was initially constructed late in 1905, and Port Everglades was originally constructed in 1927. Miami was deepened to its current depth with deepening resulting in all three offshore reefs being cut, in 1991 and Port Everglades was deepened to -45 feet and widened from 300 feet to 500 feet in 1981. *A. cervicornis* has been documented at Miami Harbor on the southern edge of the entrance channel and additional colonies have been documented on the northern side of the channel, within 200 feet of the channel edge, unlike Port Everglades where the closest documented colonies of *A. cervicornis* are more than 500 feet to the south of the channel and 1,400 feet north of the channel by the Corps and USN surveys. Neither channel has *A. palmata* documented as being in close proximity. Since the early 1980s, *A. cervicornis* has been documented as expanding its range northward through Broward County and into Palm Beach County, into areas previously documented as being devoid of acroporid corals in the 1970s 1980s and even the 1990s and early 2000s, or where acroporid corals were documented as being rare (*A. cervicornis*) or absent (*A. palmata*) (Vargas-Angel *et al.* 2003; Goldberg 1973, Precht and Aronson 2004). There are several natural breaks in the 2nd and 3rd reefs located between the Miami and Port Everglades channels, including one in the third reef that is more than 1,000 meters wide located more than eight km south of Port Everglades and *Acropora cervicornis* has been located north of this natural break on the third reef. Since acroporid species reproduce predominately through fragmentation (NMFS, 2005) and there are natural breaks in the 2nd and 3rd reefs located between the Miami and Port Everglades entrance channel more than seven times wider than the cut proposed for the channel extension (500 feet/ 0.15 km), Corps concludes that these dredged channels, that are narrower in width than natural breaks in the reefs, have not previously hindered, nor will they hinder in the future after deepening, the continued ability of fragments of acroporid coral species to migrate northward and continue to expand the species range in southeast Florida, as habitat conditions warrant.

Hopper Dredging.

If sandy material is present in the outer entrance channel, the Corps may utilize a hopper dredge to remove the sand overburden. This material will be placed in the ODMDS. No direct impacts (breakage, removal or direct burial of *Acropora sp.*) are anticipated from hopper dredging activities associated with the sand removal operations, since the hopper dredge will not leave the channel and there is no known *Acropora sp.* in the Federal channel or on the channel walls. The hopper dredge locations will be monitored at all times via the DQM system, which includes a dredge and scow tracking function. If the dredge leaves the channel, the Corps will be able to determine when and where this occurred and the area can be surveyed for any potential damage or adverse effects. No direct impact to designated critical habitat located north or south of the entrance channel is expected to occur as a result of the use of a hopper dredge. The channel walls and bottom of the existing channel are not designated critical habitat (NMFS, 2008b) since they are considered part of a "maintained channel" as detailed in 50 CFR §226.216 (c)(2).

Clamshell or Backhoe Dredging.

Clamshell dredging environmental impacts in unconsolidated sediment include resuspension of sediments when the clamshell drops onto the bottom and as material washes from the bucket as it rises through the water column. Operational controls such as reducing the bucket speed as it drops to the bottom and as it rises through the water column will reduce impacts, as will use of a closed bucket system.

Backhoe marine excavator dredging environmental impacts in unconsolidated sediment are similar to those of a clamshell dredge, as are the operation controls to reduce that impact. The key is slowing the movement of the bucket through the water. Environmental impacts are significantly less for a backhoe marine excavator dredge removing fractured (blasted) rock as the volume of fine grained sediment is significantly less in fractured rock than unconsolidated sediment and as a result the potential for sediment resuspension is reduced. The same operational controls can be applied to fractured rock as unconsolidated sediment, basically slowing the bucket's speed in the water.

The clamshell and backhoe dredges will "spud down" in the channel proper, and as such, have no direct impacts to hardbottom outside of the channel. No direct impact to designated critical habitat located north or south of the entrance channel is expected to occur by use of a clamshell or backhoe dredge. The channel walls and bottom of the existing channel are not designated critical habitat (NMFS, 2008b) since they are considered part of a "maintained channel" as detailed in 50 CFR §226.216 (c)(2).

Cutterhead Dredging.
Environmental impacts from cutterhead dredges include localized suspended sediment along the bottom of the excavation site around the cutterhead and fine-grained sediment turbidity plumes from barge overflow or pipeline leaks. This can be reduced or eliminated by restricting the amount of overflow time, eliminating barge overflow, and performing regular inspections of the floating pipeline. Locating barges the furthest possible distance from resources can further reduce environmental impacts

Incidental Impacts due to Cutterhead Dredge Equipment.
Anchors are placed to both sides of the dredge to provide the ability to swing the cutterhead dredge. The anchors are placed using a crane on a workboat. If traditional cutterhead dredging is used with unrestricted anchor/cable placement as a construction method to deepen the entrance channel, additional direct impacts to both low relief and high relief hardbottom reefs would occur due to anchoring and cable systems for the cutterhead vessel. If the selected contractor uses the worst-case anchor-cable setup, the anchors will be placed at the apex of each triangle approximately 150 feet from the channel edge and a cable brought back to the dredge. This cable will move along the bottom as the dredge moves forward until it reaches the apex of the triangle. At that time, the anchor would be relocated and the process repeated. Figure 65 provides a worst-case scenario of potential hardbottom impacts with this construction method. The potential exists for up to approximately 17.13 acres of all reef habitat types (inner, middle and outer) as well as nearshore hardbottom and rubble zones to be impacted based on the maximum number of anchor positions with any impacts to hardbottom or coral habitats (A total of 69 anchor placement sites with 54 placed in coral/hardbottom environments), and footprint of cable movement (maximum 0.32-acre impact/anchor site) (Figure 33). The number of anchor sites and the distance of the

anchor from the channel edge, thus the length of cable, may increase or decrease, dependent upon what equipment type and size contractors propose.

Implementation of an anchoring and vessel operation plan to effectively minimize anchor and cable impacts to hardbottom habitat will occur through the Request for Proposal (RFP) process and will include incentives to encourage potential contractors to avoid reef impacts. The evaluation criteria in the RFP will consider the technical aspects of the contractor's proposal as the most significant factor. As a result, the vessel operational and anchoring plan that best avoids or reduces impacts to reefs would receive the highest evaluation and the incentives that follow. Potential ideas provided by dredging companies and other consultants that would probably appear in contractor proposals for evaluation during the RFP process include:

- Use of surge buoys along the anchor cable to help lift it up off the reef areas during dredging operations to minimize the area impacted by the anchor cable; reviewing an assessment of the impacts associated with the 1991 deepening at Miami Harbor where anchors and cables were used in concert with surge buoys, the impact of placement and utilization of each anchor was 0.029 acres. If a contractor proposes a similar method as was used in 1991 during the RFP process, the impact per anchor site would be decreased by approximately 93 percent.
- Restricted anchor placement, which restricts placement of the anchors for the cutter-suction dredge to within the channel edge limits. That method reduces impacts but almost doubles dredging time since only half of the channel can effectively be dredged at a time.

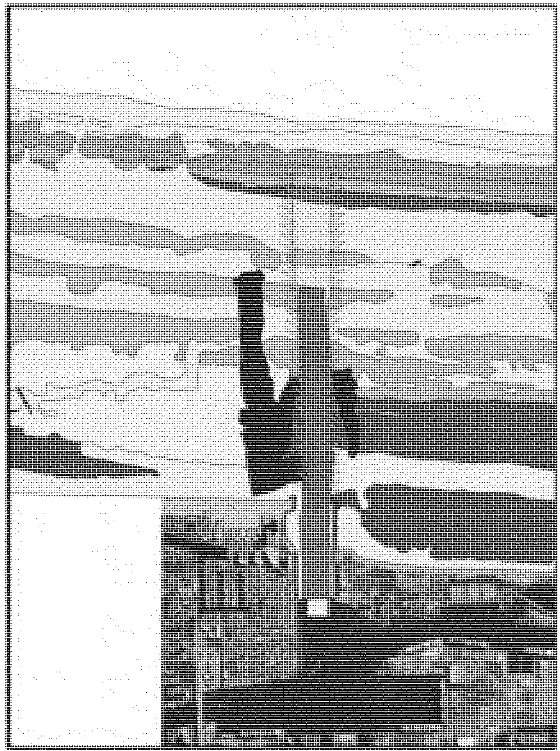


Figure 33 - Anchor/Cable Placement Area for Port Everglades - Traditional Cutterhead Dredge Placement Scheme

If the worst case anchor-cable setup is used by the selected contractor, the anchors will be placed at the apex of each triangle approximately 150 feet from the channel edge and a cable brought back to the dredge. This cable will move along the bottom as the dredge moves forward until it reaches the apex of the triangle. At that time, the anchor would be relocated and the process repeated.

After reviewing the monitoring reports from the 1980 channel deepening at Port Everglades where a traditional anchor/cable configuration was utilized with impact monitoring (CSA, 1981), the Corps determined that although the report states that no adverse impacts associated with the deployment of an anchor/cable configuration were documented, impacts may occur. A review of an Habitat Equivalency Analysis (HEA) conducted for the Hillsboro Inlet navigation district associated with injury to offshore hardground by "cables dragging across or near the reef surface by a barge during... dredging operations" demonstrates the potential for detachment and abrasive injuries to hard corals, octocorals and sponges. To be conservative, the Corps believes that the unrestricted placement of anchor/cables may result in similar impacts (NCRI, 2003). During the damage assessment phase of the HEA, NCRI documented that 2.24% of hard corals in the impact area were injured, 7.7% of octocorals and 34% of barrel sponges. Assuming that *A. cerivcornis* had been located in preconstruction surveys, and relocated any *A. cerivcornis* from the project area, the remaining smaller *A. cerivcornis* colonies would be adversely affected. The Corps has applied the percentage of hard coral impacts from the NCRI, (2003) assessment to any remaining *A. cerivcornis* still in the project area after transplantation is complete. This means that 2.24% of the remaining *A. cervicornis* could be injured by the use of unrestricted anchor/cable placement and for the purposes of this consultation should be considered lethally taken. The movement across the reef by the cable is a onetime event and has no adverse effect on designated critical habitat as it does not remove or alter the physical structure of the substrate, it only impacts the organisms attached to the substrate.

Effects of Rock Pre-treatment/ Confined Underwater Blasting.

A literature review of the effects of open-water blasts on invertebrates (including corals and *Millepora sp.*) by Keevin and Hempen (1997) states the following:

> "The results of all the studies reviewed indicate that invertebrates are insensitive to pressure related damage from underwater explosions. This may be due to the fact that all the invertebrate species tested lack gas-containing organs which have been implicated in internal damage and mortality in vertebrates. Underwater explosion produce a pressure waveform with rapid oscillations from positive pressure to negative pressure which results in rapid volume changes in gas-containing organs. In fish, the swimbladder, a gas-containing organ, is the most frequently damaged organ (Christian 1973; Faulk and Lawrence 1973; Kearns and Boyd 1965; Linton *et al.* 1985a; Yelverton *et al.* 1975). It is subject to rapid contraction and overextension in response to the explosive shock waveform (Wiley *et al.* 1981). Species lacking swimbladders or with small swimbladders are highly resistant to explosive pressures (Aplin 1947; Fitch and Young 1948; Goertner 1994). For example, Wiley *et al.* (1981) and Goertner *et al.* (1994) noted that hogchokers (*Trinectes maculatus*), which lack swimbladders, were extremely tolerant of underwater explosions, and greatly exceeded the tolerance of any species with swimbladders that they had tested. Goertner *et al.* (1994) found that hogchokers were not killed beyond a distance of 1-m from a 4.5 kg charge of pentolite.
>
> "Gas-containing organs have also been implicated as a causative factor of internal damage and mortality in other vertebrate species exposed to underwater explosions. Sailors exposed to depth charges and torpedo explosions, while escaping their sinking ships during World War II, suffered damage to gas-containing organs (Cameron *et al.* 1944; Ecklund 1943; Gage 1945; Palma and Uldall 1943; Yaguda 1945). The lungs, stomach, and intestines, all gas-containing organs, were ruptured or hemorrhaged, while other organs were relatively unaffected. Similar results have been observed in underwater explosion tests with other mammalian species (Richmond *et al.* 1973)."

Based on the fact that acroporid corals are invertebrates, and lack gas containing organs like swim bladders, lungs, etc., and that no acroporid corals have been documented in the project footprint, the Corps concluded that pre-treatment of hard rock in the outer entrance channel with confined blasting would not have any impact on acroporid corals. NMFS concurred with this determination in the September 2011 Biological Opinion issued for the expansion of Miami Harbor where *A. cerivcornis* has been documented directly adjacent to the channel.

Additionally, the Corps will be conducting sedimentation and turbidity monitoring in the project area, adjacent to the blast sites that will detect any potential effects of blasting on small acroporid colonies discovered during pre-construction surveys, yet not transplanted out of the project area before construction due to size. This data will be recorded and could be utilized by NMFS and the Corps for future consultations where pre-treatment of hard rock is needed throughout the range of acroporid corals.

Indirect Impacts to Critical Habitat

Although there is published literature concerning the effects of sedimentation and turbidity on coral reefs throughout the world, there is a paucity of peer reviewed published data specific to the recent dredging events that have taken place in southeast Florida. There are numerous published papers specific to Caribbean coral reefs that in context can be applied to corals in Florida (Rogers 1983; Rogers 1990; Dodge and Vaisnys 1977, Bak 1978), however, peer-reviewed literature specific to monitoring of dredging projects in south Florida is very limited. Corps reviewed four monitoring reports and two peer reviewed studies from recent projects in documented *Acropora* habitat between 1980 – 2007 where sedimentation and turbidity data were collected not only at sites adjacent to the channels or borrow sites, but also from background sites so that potential indirect impacts associated with dredging could be detected in addition to background impacts from natural events.

The four projects that were reviewed were: (1) Port Everglades entrance channel widening and deepening project conducted in 1980-1981; (2) Broward County Shore Protection Project conducted in 2005; (3) Key West Harbor O&M dredging 2004-2006 and (4) Key West Harbor O&M dredging 2007 (Jordan *et al.* 2010; Gilliam *et al.* 2006; Fisher *et al.* 2008; CSA 2007; CSA 2007a and CSA 1981). These projects utilized cutterhead, hopper, and clamshell dredges (or a combination thereof) for their operations.

From a turbidity and/or sedimentation standpoint, a hopper dredge has the highest likelihood of adverse effect due to the overflow of water being returned from the hopper to the surrounding environment. With this overflow, "fines" (usually clays or silts which are light enough not to have settled out in the hopper) are returned to the water during dredging operations. The clamshell or bucket dredge ranks second since the material may or may not be enclosed in a bucket, and if it is not enclosed, material may escape that bucket into the surrounding environment. The dredging method with the lowest level of associated sedimentation or turbidity is the cutterhead dredge. This dredge has suction that removes the sediment, transports it to the surface where it is either pumped into the receiving disposal site, or placed in a scow for transport to a disposal site. The Key West O&M projects in 2004-2006 and 2007 utilized both a clamshell dredge and a hopper dredge. The Broward County Shore Protection Project utilized a hopper dredge and the Port Everglades expansion project in 1980 utilized a cutterhead dredge. Understanding which types of equipment were utilized allows for a comparison across projects of results regarding turbidity and/or sedimentation monitoring.

A review of these four projects found that using BMPs for turbidity and sedimentation control (e.g. ceasing dredging when turbidity levels exceed permitted standards) are protective of the coral and hardground environments surrounding South Florida sand borrow sites and navigation channels. Impacts associated with storms can have sedimentation rates in excess of 400 times those seen with a dredging project. The following information is provided from the Key West Harbor O&M project. (CSA 2007):

> "Average daily sedimentation rates at the monitoring sites fluctuated based on weather conditions and ambient suspended sediment load in the surrounding waters. This was especially evident during periods of winter cold-front activity during November 2005 and January 2006, with associated rough seas and high turbidity. During these periods, average daily sedimentation rates were more than twice as high as during the previous November and January, and up to 25 times above levels observed during June 2004 at several sites. The passage of hurricanes during August and September of 2004 and July, September, and October of 2005 provided the most dramatic increase in levels of sediment re-suspension (Figures 3.23 to 3.25 [Figures 32]). Average daily sedimentation rates at several of the Hawk Channel seagrass sites and the bank reef sites were up to 400 times higher than levels noted during June 2004. Following Hurricane Dennis in July 2005, nearly every sediment trap site had at least a ten-fold increase in the average daily sedimentation rate compared to the previous month.
>
> "Site BP-41, a bank reef monitoring site adjacent to the Main Ship Channel, had an average daily sediment deposition rate of 18 $mg/cm^2/day$ for August 2005, while in the following month when Hurricanes Katrina and Rita impacted the area, the average daily sediment deposition rate recorded in the traps increased to 1,219 $mg/cm^2/day$, 67 times the previous month's level. For Site SP-37, a seagrass site located adjacent to the Main Ship Channel, there was an increase in average daily sediment deposition rate during this same period from 14.4 $mg/cm^2/day$ up to 3,529.7 $mg/cm^2/day$, 245 times the August levels."

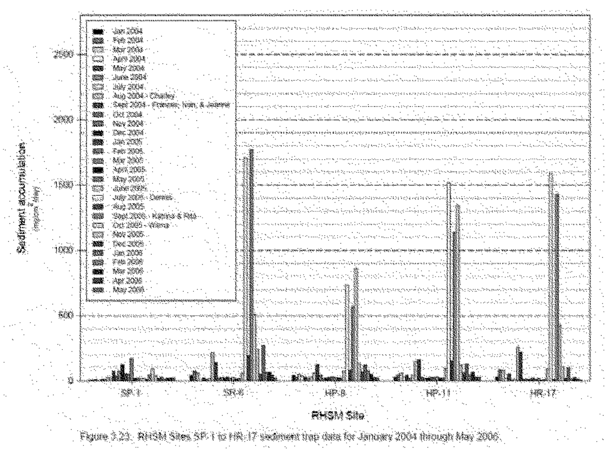


Figure 34 Key West RHSM Sites SP-1 to HR-17 sediment trap data (January 2004 - May 2006)

Monthly Sediment Trap Data (2005)

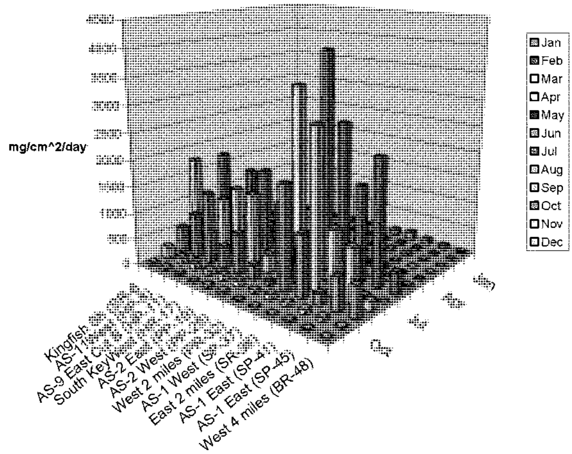


Figure 35 - Monthly Sediment Trap Data - Key West O&M 2005

Additionally, Gilliam *et al.* (2006) and Fisher *et al.* (2008), found there to be no detectable impacts to corals living on the hardgrounds adjacent to the borrow areas utilized for the Broward County shore protect project. While the Key West and Broward County projects were required by regulatory permit to maintain a lower turbidity threshold (15 NTUs), a review of the monitoring from the Port Everglades channel widening and deepening from 1980-1981 continues this trend in showing little to no effect of dredging operations on corals adjacent to dredging areas (CSA, 1981). The Port Everglades deepening project in 1980-1981 was not bound by any state or federal agency issued turbidity level that required the dredge to cease operations. The Corps did monitor turbidity and sedimentation levels throughout the dredging operations, which is most similar in nature to the dredging currently proposed, and the final report for the Port Everglades deepening conducted states, "Due to the powerful suction ability of the dredge, only a small fraction of the dredged material entered the water column. No significant increase in turbidity levels was detected during daily monitoring of the dredging operations by U.S. Army Corps of Engineers environmental contractor." (CSA 1981).

The examples of the adverse effects of turbidity or sedimentation on coral species often cited by resource managers are commonly projects in third world countries without the strict water quality protections that are in place in the U.S. (Bak 1978); or are studies where the material used to simulate dredged material is not the same sediment size or mineral composition of the material proposed to be dredged (Telesniki and Goldberg

1995) and thus are not a good substitute for the effects of projects bound by the water quality restrictions required by the State of Florida under the Clean Water Act. These restrictions are protective of water quality by limiting turbidity; they are also protective of coral species, including *Acropora sp.* and its designated critical habitat, located near dredging operations where material is being removed from the bottom by a dredge. Dredging projects take place in a spatially and temporally finite area and thus impacts associated with them, if present, should be detectable within this same finite footprint. A review of these four projects, three of them in the very recent past, demonstrates that no adverse effects of dredging were detectable (or in the case of Broward county were detectable as monitoring continues) (Gilliam *et al.* 2006; Fisher *et al.* 2008; Jordan *et al.* 2010; CSA 2007; CSA 2007a; CSA 1981).

Of the four projects, only the Key West O&M project documented any acroporid corals adjacent to dredging areas, which may be attributable the lack of focus on *Acropora* on the other (and, indeed, most) projects prior to the listing of the two species under the ESA. Between the two dredging projects in Key West, *A. cervicornis* was documented along the east side of the Key West entrance channel near station BP-41. The 2007 dredging event took approximately four months between May and August. These colonies did not show any impacts different than control corals (CSA 2007) and none of the recorded changes were attributed to the dredging.

To protect hardgrounds in project areas including those that support *A. cervicornis*, the Corps requires turbidity monitoring with all of its projects. It is a standard practice for the Corps to monitor sedimentation associated with dredging projects where corals and coral habitats are adjacent to the project area. This has been standard practice for more than 30 years (CSA 1981; CSA 2007; CSA 2007a).

In the 2009 biological opinion for dredging associated with sand mining dated October 21, 2009 (Consultation # F/SER/2009/00879), NMFS reviewed effects of sedimentation associated with *A. cervicornis*. NMFS states:

> "Additionally, Rogers (1983) tested sedimentation rates on *A. cervicornis*, among other coral species, and determined that daily doses of sediment at a rate of 200 mg/cm2/day had no effect (Rogers 1990)."

Given the strong similarities between the proposed action and the Key West and Port Everglades projects previously reviewed, we believe it is reasonable to assume the impacts documented at the Key West and Port Everglades sites will be similar to those likely to occur during the proposed action. Adverse affects from sedimentation are also less likely to occur in the presence of strong oceanographic currents (Rogers 1990) because sediments are swept off corals. This phenomenon was also observed at the Port Everglades project in 1980. The influence of the relatively strong Gulf Stream in the action area is also likely to reduce any adverse affects from sedimentation.

Concern has been raised that the Corps is utilizing data from a project (Key West) that had restrictions on the maximum allowable NTUs (15) that are lower than those that will be required for Port Everglades (29 NTU). The specific concern is that higher turbidity values allow for higher sedimentation rates on adjacent habitats, however, the scientific literature does not support this concern. There is no direct correlation between turbidity and sedimentation rates, or between turbidity and total suspended solids that can be uniformly applied across differing projects (Davies-Colley and Smith, 2001; Clarke and Wilber, 2008). The effects of sedimentation are a dose-response relationship, and the results of that relationship specific to dredging projects in SE Florida has been reported here – both at the 15 NTU and 29 NTU levels, and for both levels, the effects of sedimentation, with proper *in situ* monitoring, showed no adverse effect on coral species in general (Port Everglades and Broward County), and specifically *Acropora sp.* (Key West) near dredging projects. The Port Everglades expansion project (like Key West and Miami) will include sedimentation monitoring as a project component. The substrates being dredged are composed of limestone (calcium carbonate) rock, and as cited by NMFS in 2011, Torres (2001) found

> "In sites with higher carbonate percentages and corresponding low percentages of terrigenous sediments, growth rates were higher. This suggests that resuspension of sediments and sediment production within the reef environment does not necessarily have a negative impact on coral growth while sediments from terrestrial sources increase the probability that coral growth will decrease, possibly because terrigenous sediments do not contain minerals that corals need to grow."

Since the rates of sedimentation observed during the Key West and Port Everglades deepening monitoring were within the bounds of sedimentation documented to be occurring naturally, and those were far less than this 200 mg/cm2/day threshold set by Rogers (1983) cited by NMFS (2009) as a daily dose threshold, we believe adverse effects to *A. cervicornis* and designated critical habitat from increased sedimentation will be insignificant. This determination is consistent with NMFS' previous findings in NMFS biological opinions (2009, 2011) where in both cases NMFS determined the effects of sedimentation on critical habitat to be temporary in nature.

Dredged Material Disposal Impacts. Potential barge environmental impacts could occur as the barge is loaded if material is allowed to spill over the sides and during transport if the barge leaks material. Operational controls eliminate spilling material during loading by monitoring the dredge operator to make sure that the dredge bucket swings completely over the barge prior to opening the bucket. Requiring barges in good repair with new seals minimizes leaking during transport. Hauling rock is often damaging to transport barges, so intermediate inspection and repairs may be required during the project to maintain the barges in good working condition. Seals may require replacement. Proper use of the ODMDS minimizes the environmental impacts during disposal. The barges will be required to use positioning equipment to place dredged material within the designated ODMDS and inspectors may be required to monitor disposal activity. The Corps's required monitoring of vessels in ullage and location ensure that the dredged material is being disposed of in the approved location. Disposal of dredged material will have no impact on *Acropora sp.* corals or DCH. The ODMDS is not within the boundaries of DCH as the site is located offshore of Fort Lauderdale, beyond the edge of the continental shelf in greater than 500 feet of water.

Sedimentation and Turbidity Monitoring. Monitoring of the Port Everglades expansion project will take place on numerous levels including physical monitoring of scow and dredge location relative to reefs and other mapped resources and turbidity and sedimentation monitoring during construction. Monitoring protocols will adapt aspects from other monitoring projects previously referenced, including Key West O&M (CSA 2007; CSA 2007a); Broward County SPP (Gilliam *et al.* 2006 and Fisher *et al.* 2008) and Miami Harbor that is scheduled to begin construction in 2013. Corps will develop detailed monitoring plans prior to construction with the contractor and local sponsor, as well as the federal, state and local resource agencies, and expects NMFS-OPR staff to participate in the development of those plans.

Effects on Designated Critical Habitat by Disposal Activities

As previously detailed, the ODMDS is beyond the 30 meter contour. If the Corps opts to build an artificial reef site as compensatory mitigation for unavoidable impacts of the project on the 2nd and 3rd reef this reef would be potentially be built in the sand trough located between the 2nd and 3rd reef. The mitigation will be constructed with either rock mined from the entrance channel, or native limestone purchased from a quarry. Based on HEA, a total of 37.5 acres of artificial reef would be required to offset unavoidable impacts associated with the TSP. At this time, the Corps is planning on constructing artificial reef for this mitigation, however, Broward County has recently request the Corps review additional mitigation options in lieu of reef construction. The Corps is considering the options presented by the County. Per the final mitigation plan included in the FEIS:

> Two types of mitigation reefs will be constructed: High Relief, High Complexity (HRHC) reefs (exceeding three feet of vertical relief) and Low Relief, Low Complexity (LRLC) reefs (approximately three feet of relief), based on data collected in 2006 (DC&A 2009). The HRHC reefs are intended to mitigate for impacts to high relief habitat (i.e., linear or spur-and-groove reefs) and the LRLC reefs are intended to mitigate for impacts to lower relief reef (i.e., pavement or channel wall) and hardbottoms outside of the project footprint (i.e., in the indirect effect area). The two reef types will be deployed in acreages proportional to direct impacts expected to each type of natural reef habitat. The ratio of HRHC to LRLC is 60%/40%.
>
> Limestone rock excavated from the STB, MTB, IEC, and the OEC may be used in reef construction and, if necessary, supplemented with quarried limestone. Hence, rock excavation will commence inside the harbor to create habitats at selected mitigation sites, and then proceed to dredging the entrance channel; i.e., dredging and reef installation will occur simultaneously. The construction contractor will be allowed the option of purchasing quarried native limestone in lieu of quarrying the material from within the project boundaries. HRHC reefs will consist of limestone rock boulders from 1.0 to 10.0 ton each, having a minimum density of 140 pounds per cubic foot. The material will be deployed in shore-parallel strips 50-100 feet wide to mimic the orientation of typical natural reefs. This reef design will have a vertical relief of 3-6 feet and boulders will be partially stacked to provide the maximum structural complexity and to provide

> refugia for cryptic and reclusive species. As interstitial sand patches associated with reef habitat are thought to be important in the ecological function of the reef habitat, the reef footprint will contain approximately 20 percent open sand surface. Temporary buoys delineating the deployment strip will mark areas for deployment. Corner buoys for the sites shall be placed using DGPS with sub-meter accuracy. Natural limestone provides an ideal substrate for the establishment of a reef community. An additional advantage of limestone rock boulders is aesthetic. Once colonized by the reef community, the reef is almost indistinguishable from a natural reef, enhancing its value as a recreational resource. HDHC reefs are intended to provide persistent habitat with higher complexity and habitat diversity than typical natural nearshore hardbottom reefs. It may also be desirable to include prefabricated structures such as Reef Balls™ in the HRHC reef arrays. These modules, which provide a high degree of complexity and void space, are widely used in artificial reef construction and have proven stable in shallow water applications.

This is the same type of artificial reef that is being constructed as part of the Miami Harbor expansion that NMFS reviewed under the September 2011 Biological Opinion. Construction of these mitigation reefs can also serve as potential habitat for Acroporid corals to settle onto, since they will be bare limestone, although they would not be considered DCH per 50 CFR 226.216(c)(2). Additionally, the site could be used in the future by Broward County, or other permitted organizations to transplant corals from other impactive projects. During construction, a buffer between the selected sites and any adjacent hardground habitats will be maintained at all times to ensure no adverse impacts associated with mitigation construction. Monitoring of the mitigation reefs will consist of both physical and biological components.

As the artificial reef site would be placed on sandy substrate, the Corps believes that such a site would lack the exposed rock or hardbottom necessary to find that the placement areas contain the PCE for Acroporid coral critical habitat as detailed in the final rule (NMFS, 2008b). Additionally the monitoring of the surrounding hardbottom habitats will ensure no adverse effects occur during construction.

Effects of Transplantation

Although no *Acropora* sp. have located in the project direct or indirect footprint, the Corps can conceptually estimate impacts to *Acropora*, should it be located after this consultation is complete, either before or during construction. Prior to initiation of any dredging activities, the Corps will require the contractor to perform a baseline survey of the project area and should they locate an Acropora in the project direct or indirect footprint, they will be required to relocate any *Acropora sp.* colonies greater than 10cm located within 150 meters of the outer entrance channel in accordance with Appendix A of "*Acropora cervicornis* Transplantation Protocols for Miami Harbor Expansion Project" Endangered Species Act - Section 7 Consultation Biological Opinion for Dredging and expansion of Miami Harbor, Miami-Dade County, Florida (Consultation Number F/SER/2011/00029) (NMFS 2011).

This transplantation effort would be consistent with reasonable and prudent measures included in recent biological opinions for beach nourishment and harbor deepening activities (NMFS 2009; NMFS 2011) where *A. cervicornis* was in the action area and is expected to reduce the effect of the anticipated take. Collection of small *A. cervicornis* fragments (i.e., approximately 3-cm fragments) from each transplanted coral would be required to help achieve recovery goals for the species. The fragments will be grown in nurseries by either Broward County or another permitted nursery, increasing population sizes and protecting genetic diversity. These fragments will be collected via careful breaking of the branch tips of the coral colonies using pliers or other small hand tools, or will be fragments of opportunity created during transplantation. The collections will be made by coral experts and trained professionals. Even though these actions involve directed take of *A. cervicornis*, they constitute a legitimate take reduction method (and NMFS has previously included this as a Reasonable and Prudent Measure) because it reduces the level of potential lethal take of *A. cervicornis* during the deepening of the entrance channel by cutterhead dredge, and allows the colonies to be collected and relocated out of the impact area where they will have a high likelihood of continued survival. The Consultation Handbook (USFWS and NMFS 1998) expressly authorizes such directed take as an RPM (see page 4-53). Therefore, NMFS should evaluate the expected level of *A. cervicornis* take through transplantation, so that these levels can be included in the evaluation of whether the proposed action will jeopardize the continued existence of the species.

NMFS has previously stated:

> "...that the collection of small tissue samples from A. cervicornis colonies will result in temporary effects on coral colonies. The collection of approximately 3-cm-long branch tip tissue samples from single staghorn coral colonies will result in a small reduction of coral colony biomass; however, this effect is expected to be temporary with recovery through tissue replacement and/or coral colony growth. Acropora cervicornis' dominant mode of reproduction is through asexual fragmentation (see Section 3.2 for further discussion). In the congener Acropora palmata, lesions at the point of fragment detachment have been shown to begin regeneration within two weeks (Lirman 2000) of fragmentation, with regeneration rates being positively correlated with decreasing size of lesion and proximity to growing tip. The size of the lesion created in this project will be a function of the diameter of the branch being clipped. The diameter of staghorn coral branches ranges from 0.25 to 1.5 cm. Lirman (2000) showed that a 3-cm2 lesion regenerated completely within 100 days. Given that the rate of recovery is an exponential decay, it is expected that lesions 0.25 to 1.5 cm in diameter (less than 2.25 cm2) will recover much faster than in Lirman's experiment.
>
> Furthermore, the proposed collection of tissue samples from A. cervicornis colonies will occur at the outermost portion of the branch tip of the coral colony. Soong and Lang (1992) observed that, in A. cervicornis, large polyps and basal tissues located 1.0 to 4.5 cm from the colony base were infertile, and larger eggs were located in the mid-region of colony branches. Gonads located within 2 to 6 cm of the colony's branch tips always had smaller eggs than those in the mid-region (Soong and Lang 1992). Larger colonies (as measured by surface area of the live colony) have higher fertility rates (Soong and Lang 1992). Thus, the effect of this activity on coral colony reproduction is insignificant. Given that the collected tissue samples are small in size (~3 cm) relative to coral colony size, that the effects of collecting such fragments are temporary, that fragmentation is a natural reproductive mode, and that these fragments will be collected from the outermost portion of the coral branch tip where smaller eggs are found, it is not likely that

survival or reproductive output of staghorn coral colonies will be measurably reduced by the proposed action.

Coral transplantation can successfully relocate colonies that would likely suffer injury or morality if not moved. Provided that colonies are handled with skill, are reattached properly, and the environmental factors at the reattachment site are conducive to their growth (e.g. water quality, substrate type, etc.), many different species of coral have been shown to survive transplantation well (Maragos 1974, Birkeland et al. 1979, Harriott and Fisk 1988, Hudson and Diaz 1988, Guzman 1991, Kaly 1995, Berker and Mueller 1999, Tomlinson and Pratt 1999, Hudson 2000, Lindahl 2003, NCRI 2004). Herlan and Lirman (2008) documented a 17.3 percent mortality rate in Acropora coral fragments after transplantation to a coral nursery in Biscayne National Park. The authors stated the mortality rate might have been increased due to stress caused by relatively high water temperatures during fragmentation not necessarily the process itself. This observation has been supported by other nursery managers who report post-relocation coral fragment mortality rates closer to 1 percent (NMFS, 2009). Transplantation of coral colonies less than 10 cm in size is not feasible because detaching such small colonies would likely result in breakage. Survivability of transplanted coral colonies less than 10 cm in size is also very low due to injury and the decrease in the overall surface area of living tissue, which reduces the colony's resilience to stress." (NMFS, 2009).

We believe that unless Acroporid corals are relocated from the impact area, if they were found to be present, up to 50% could be injurious taken or lethally taken due to the impacts of anchor/cable usage associated with cutterhead dredging. These effects are detailed further in the BA under the heading "Dredging - Deepening Entrance Channel Utilizing Cutterhead Dredge". We believe coral transplantation will be highly successful and relocating these corals outside the entrance channel is appropriate to minimize the impact of this take. Similar habitat, influenced by the same environmental conditions currently affecting these colonies, exists both north and south of the entrance channel beyond the 150-m indirect impact zone, and has been documented to support *A. cerviconis* (USN, 2011; Gilliam et al, 2011). Because suitable transplantation habitat is nearby and proper handling techniques are available and will be required (see Appendix A of Miami Harbor Biological Opinion), we have confidence that transplantation survival rates similar to those noted by NMFS in the 2009 biological opinion will be likely in this case. NMFS has previously stated a maximum estimated coral fragment mortality rate of 17% (NMFS, 2009), although this may be artificially high, brought on more by unusual environmental conditions than actual transplantation. To be conservative, we use a 17% mortality rate in our estimates, but believe actual mortality may be lower. Therefore, we anticipate 100 percent success in reattachment and an 83% survival rate of transplanted colonies. These same estimates were previously utilized by NMFS (2009).

Summary Effects Determination

The Corps has determined that the proposed expansion of Port Everglades may adversely affect listed and proposed species within the action area and requests initiation of formal consultation with NMFS.

SUMMARY OF EFFECT DETERMINATIONS

Project effect determination summary for sea turtle *sp.*, Johnson's seagrass, Acroporid *sp.*, large whales, and smalltooth sawfish (No Effect (NE – green); May Affect Not Likely to Adversely Affect (MANLAA – orange), May Affect Likely to Adversely Affect (MALAA – yellow), and Not Likely to Adversely Modify (NLAM – orange)

Proposed Activity	Effect Determination													
	Sea Turtle					Johnson's seagrass	Acroporid Sp.	Large Whales						Smalltooth Sawfish
	Leatherback	Loggerhead	Green	Kemp's Ridley	Hawksbill			NARW	Humpback	Sperm	Blue	Sei	Fin	
Hydraulic Hopper limited to the channel bottom	NE	MALAA	MALAA	MALAA	MALAA	MALAA	NE	NE	NE	NE	NE	NE	NE	NE
Hydraulic Cutterhead w/unrestricted anchor/cable placement	NE	MANLAA	MANLAA	MANLAA	MANLAA	MALAA	MANLAA	NE	NE	NE	NE	NE	NE	NE
Mechanical Dredge (clamshell or back-hoe)	NE	MANLAA	MANLAA	MANLAA	MANLAA	MALAA	MANLAA	NE	NE	NE	NE	NE	NE	NE
Pre-Treatment with blasting	NE	MANLAA	MANLAA	MANLAA	MANLAA	NE	MANLAA	NE	NE	NE	NE	NE	NE	NE
Disposal - ODMDS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Disposal – Reef Mitigation	NE	NE	NE	NE	NE	NE	MANLAA	NE	NE	NE	NE	NE	NE	NE
Transplantation of Acropora sp.	NE	NE	NE	NE	NE	NE	MALAA	NE	NE	NE	NE	NE	NE	NE
[redacted]														
Critical Habitat	NLAM	NE	NLAM	NE	NLAM	NLAM	NLAM	NLAM	NE	NE	NE	NE	NE	NLAM

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ESA Consultation History - Port Everglades Feasibility Study
Consultation # F/SER/2002/00626

- September 8, 2001 - Request for Species List from Corps to NMFS-SERO
- March 25, 2002 - Biological Assessment from Corps to NMFS-SERO
- June 24, 2002 - Corps contacts NMFS to verify package has arrived and check on 30-day letter. Email from E. Hawk that package arrived, assigned log #F/SER/2002/00626 and assigned to Bob Hoffman. No 30-day letter ever received from NMFS.
- 2003 - Due to changes in the ship simulations for the project and potential change in impacts, Ms. Terri Jordan contacted Mr. Hoffman and asked him to set the BA aside, as a revision would be coming once the new ship simulations were complete.
- September 12, 2004-Letter from James Duck to Ms. Georgia Cranmore. Recommended Plan and included Corps' Biological Assessment.
- September 17, 2004 - Revised Biological Assessment from Corps to NMFS-SERO.
- November 17, 2004 - Corps calls to check on 30-day complete letter from NMFS. Resent consultation documents via mail and email to Mr. Hoffman since NMFS unable to locate package. Package has been reassigned to Mr. Juan Levesque.
- November 17, 2004 - Email from Mr. Levesque that package is complete. No additional information required.
- No 30-day letter received.
- No requests for additional information made.
- March 9, 2005 - Ms. Jordan emails Mr. Levesque asking for status check, since NMFS database does not show any movement on project. Mr. Lévesque responses that Mr. David Bernhart had reviewed Biological opinion and his comments are being responded to and package is headed to Office of General Counsel for review and clearance.
- May 9, 2005 - proposed listing of *Acropora palmata* and *A. cervicornis* as threatened under the ESA (70 FR 24359).

- Late May 2005 - After the listing, Ms. Jordan contacted Mr. Levesque by phone to discuss the new *Acropora* proposal and how it should be handled since the consultation was not yet complete. The Corps and NMFS agreed to incorporate existing surveys of the project area, including the baseline survey and the survey from the Broward County Shore Protection Project Resource GIS system (a series of 9 CDs with GIS data on them with mapped resources in Broward County - A copy of these CDs had been provided to NMFS as part of the ESA consultation for the Broward County shore protection project and represents the most detailed assessment of reef resources in Broward County). The Corps and NMFS agreed that no additional species specific surveys would be completed due to sufficient information already being available and a lack of funding (about 2 million dollars) to complete a survey of the action area specifically for these species.
- June 23, 2005 - the Corps emailed a determination that the Port Everglades feasibility study, may affect, but was not likely to adversely affect listed Acroporid corals near Port Everglades.
- July 7, 2005 - an email was received from Mr. Levesque that stated that the opinion "had gone to GC today".
- July 27, 2005 - another email stating the opinion was still in review in the office of General Counsel.
- December 6, 2005 - email sent to Mr. Levesque and Mr. Bernhart requesting a status check on the biological opinion. No response received to this email. It is the Corps' understanding that Mr. Levesque had been deployed to assist with hurricane Katrina recovery in October 2005 and that had delayed his working on the project.
- The next communication from NMFS came on March 28, 2006. Mr. Levesque asked for information on material disposal locations. The Corps provided additional details and a graphic showing the areas via email dated March 29, 2006 as this information was included in the baseline report sent in November 2004 as part of consultation package.
- May 9, 2006 - listing of *A. palmata* and *A. cervicornis* as threatened under the ESA (71 FR 26852)
- May 17, 2006 - informed that Mr. Levesque is leaving NMFS, no information available on who will be taking over file or on the status of the file that was last

noted as "in the office of General Counsel". Numerous email and phone requests for information made to Bob Hoffman and Eric Hawk.

- June 2, 2006 - Informed by phone that Ms. Audra Livergood, NMFS Miami office will be completing the consultation.
- June 14, 2006 - Corps makes formal request for a timeline for the completion of the consultation to Mr. Bob Hoffman. Timeline not provided.
- June 21, 2006 - Met in person with Ms. Livergood at the Mineral Management Service's Information Transfer meeting in Melbourne, Florida to discuss the biological opinion and its status. Made sure Ms. Livergood had all existing survey information in the file and clarified that the Port Everglades Reef survey that had been started in May 2006 would provide additional information on the species composition at the end of the entrance channel where the project proposes to extend the channel through the third reef. This would be considered additional information for the file - in addition to the Broward and baseline surveys previously discussed. Also discussed the northern right whale finding for the opinion and the history of northern right whales transiting through the project area.
- June 23, 2006 - After conversation with Ms. Livergood in Melbourne, email received agreeing to modify conference opinion request of June 23, 2005 to consultation request for the Acroporid corals due to delays by NMFS in completing consultation.
- July 6, 2006 - Copy of draft Port Everglades Reef Report sent to all resource agencies by email (A. Livergood included).
- July 25, 2006 - Port Everglades Reef Report results presentation meeting, Port Everglades. Written comments requested to be to Corps by August 7, 2006.
- August 11, 2006 - Email draft comments from Ms. Livergood on report recommending "an active and quantitative survey designed specifically to identify and quantify the presence and abundance of /A. palmata/ and /A. cervicornis/ should be conducted for the proposed impact areas and control sites. We request that the survey design and methodology be submitted to NMFS PRD for review and comment prior to conducting the survey."

- August 11, 2006 - after receipt of the comments, Ms. Jordan contacted Ms. Livergood and discussed that while an additional survey would be nice to have, it was not feasible due to budget and schedule. Ms. Livergood offered to have NMFS review a database of known locations of Acroporid corals that has been developed as part of the listing process to see additional coral locations, not presented by the Broward County survey, baseline reports or the new Reef Survey.
- August 13, 2006 - Email from Ms. Livergood stating "I spoke to Jennifer Moore, and she said that NMFS cannot share the data yet that has been compiled for the Acropora GIS database. However, she suggested that I request a shapefile of the action area from you, and she can create a map with the Acropora data they have in-house. Would you mind sending me a shapefile of the action area for Port Everglades?"
- August 18, 2006-Letter from Mr. Bernhart- *Port Everglades Reef Mapping and Assessment, 06 July 2006 Preliminary Draft*. "NMFS PRD believes study is flawed".
- August 30, 2006 - Email to Ms. Livergood with action area. This later proved to be the original survey area provided to the Corps' baseline report contractor and covered a much larger area than the action being consulted on.
- September 7, 2006 - Email from Ms. Livergood with map of known *Acropora* colonies in the action area as provided on August 30, 2006. At this time, Corps realized that graphic of refined action area needed to be sent since the original covered much more area than the true action area.
- September 21, 2006 - Phone call between Ms. Jordan and Ms. Livergood - Re: Revised action area for Port Everglades
- September 21, 2006 - Email from Ms. Livergood requesting justification for change in action area.
- September 21, 2006 - Email to Ms. Livergood clarifying why the need for the change in action area.
- September 22, 2006 - Email to Ms. Livergood with new graphic showing revised action area.
- September 25, 2006 - Email from Ms. Livergood requesting shapefile of revised action area be sent to her and NMFS-St. Petersburg for database review.

- September 26, 2006 - Email to Ms. Livergood and Amanda Flick with shapefile of the revised action areas.
- October 12, 2006 - Updated seagrass report emailed to Ms. Livergood
- Oct 13, 2006 – Although effects determination provided earlier as part of request for consultation sent to Mr. Levesque for Acroporid dated June 2005 – at NMFS' request, the Corps prepared memo for the record with an effects determination for Acroporid corals. Memo sent by email.
- Oct. 18, 2006-Letter to Mr. Bernhart (NMFS) from Mrs. Marie Burns. Response to belief that "study is flawed".
- Mar 26, 2008-Letter from Mr. Bernhart to Mrs. Burns reiterating recommendations from August 18, 2006 letter. Concerned *cervicornis* may occur closer than 3,500 feet to the entrance channel.
- Apr 28, 2008- The Corps met with NMFS leadership and staff in St. Petersburg to discuss the project timeline, *Acropora* survey methodology and a path forward for the project. Determination was made that navigation channels in Designated Critical Habitat required alternative survey methodology, and Corps would work with NMFS SEFSC researchers to develop this methodology.
- Dec 2009-*Benthic and Fish Community Assessment at Port Everglades Harbor Entrance Channel Final Draft. Prepared by Dial Cordy and Associates Inc. for CORPS Jacksonville District.* Document finalized.
- Summer 2010 – Acropora survey with new navigation channel protocol conducted at Port Everglades.
- Oct 2010- *Acropora Coral Survey Final Report*. Prepared by Dial Cordy and Associates Inc. for CORPS Jacksonville District
- October 12, 2011 - Review of video and results of Survey completed with Robert Hoffman, Chief, ESA consultation branch, NMFS-SERO-PRD. Mr. Hoffman expressed satisfaction with methodology utilized and results of survey.
- August 2, 2011 – NMFS informs Corps of Navy *Acropora* survey that detected *Acropora* on Reef 3 and requests that CORPS hold off submittal of ESA consultation package until Navy report is complete. Corps requests copy of report from Navy when they are able to release report.

- Dec 2011-*Benthic Habitat Characterization for the South Florida Ocean Management Facility: Protected Stony Coral Species Assessment*. Prepared by Gilliam & Walker for Seaward Services completed for US Navy.
- February 13, 2012 - Corps receives Navy *Acropora* Survey.
- May 1, 2012 - Corps Environmental Branch leadership meets with NMFS PRD and HCD leadership to discuss ongoing projects and communication. Included in those discussions, NMFS-PRD leadership asks Corps to compile a complete package for the ESA consultation for Port Everglades and resubmit all materials in that complete package.
- May - August 2012 - Corps revised package, prepared new documentation and completed package for submittal to NMFS for continued consultation.
- August 20, 2012 - Corps informed that consultation has been reassigned to a new NMFS biologist - Kelly Logan.
- September 5, 2012 - Corp's Supplemental Consultation package complete, letter to David Bernhart transmitting package signed by Jason Spinning.

Sept 17, 2004

Planning Division
Environmental Branch

Ms. David Bernhart
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
9721 Executive Center Drive North
St. Petersburg, Florida 33702

Dear Mr. Bernhart:

This request for consultation replaces the original request for this project submitted to your office March 25, 2002 for the port Everglades Feasibility Study.

The U.S. Army Corps of Engineers (Corps), Jacksonville District proposes to conduct a feasibility study to assess Federal interest in navigation improvements throughout Port Everglades. An evaluation of benefits, costs, and environmental impacts determines Federal interest. This Feasibility Study was authorized by a resolution of the House Committee on Transportation dated May 9, 1996.

The Recommended Plan main elements include: widening and deepening the Outer Entrance Channel to -56 feet (-54 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), deepening the Inner Entrance Channel and Main Turning Basin to -51 feet (-49 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), widening and deepening the Southport Access Channel to -51 feet (-49 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), widening of the DCC to 310 feet and deepening the Dania Cutoff Canal to -34 feet (-32 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), constructing a Turning Basin at the intersection of the Dania Cutoff Canal and the Southport Access Channel at -34 feet (-32 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), deepening a portion of the South Turning Basin to -46 feet (-44 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth), and widening and deepening the Turning Notch to -51 feet (-49 feet authorized + 1 foot required overdepth and 1 foot allowable overdepth). Other significant construction items include relocation of the U.S. Coast Guard (USCG) Basin easterly within essentially

USCG property, port facility construction, and environmental mitigation.

Enclosed please find the Corps' biological assessment of the effects of the proposed project on listed species in the action area. A copy of the Baseline Assessment prepared for this proposed project has been sent to your office previously by email to Mr. Robert Hoffman.

We request initiation of consultation under section 7 of the Endangered Species Act concerning the effects of the proposed activities on the smalltooth sawfish, green, hawksbill, Kemp's ridley, leatherback and loggerhead sea turtles, humpback and sperm whales and Johnson's seagrass.

If you have any questions, please contact Ms. Terri Jordan at 904-232-1817 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Jordan/CESAJ-PD-EA/3453/
McAdams/CESAJ-PD-EA
Dugger/CESAJ-PD-E
Scarborough/CESAJ-DP-C
Strain/CESAJ-PD-P
Duck/CESAJ-PD

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BIOLOGICAL ASSESSMENT
PORT EVERGLADES NAVIGATION PROJECT
BROWARD COUNTY, FLORIDA

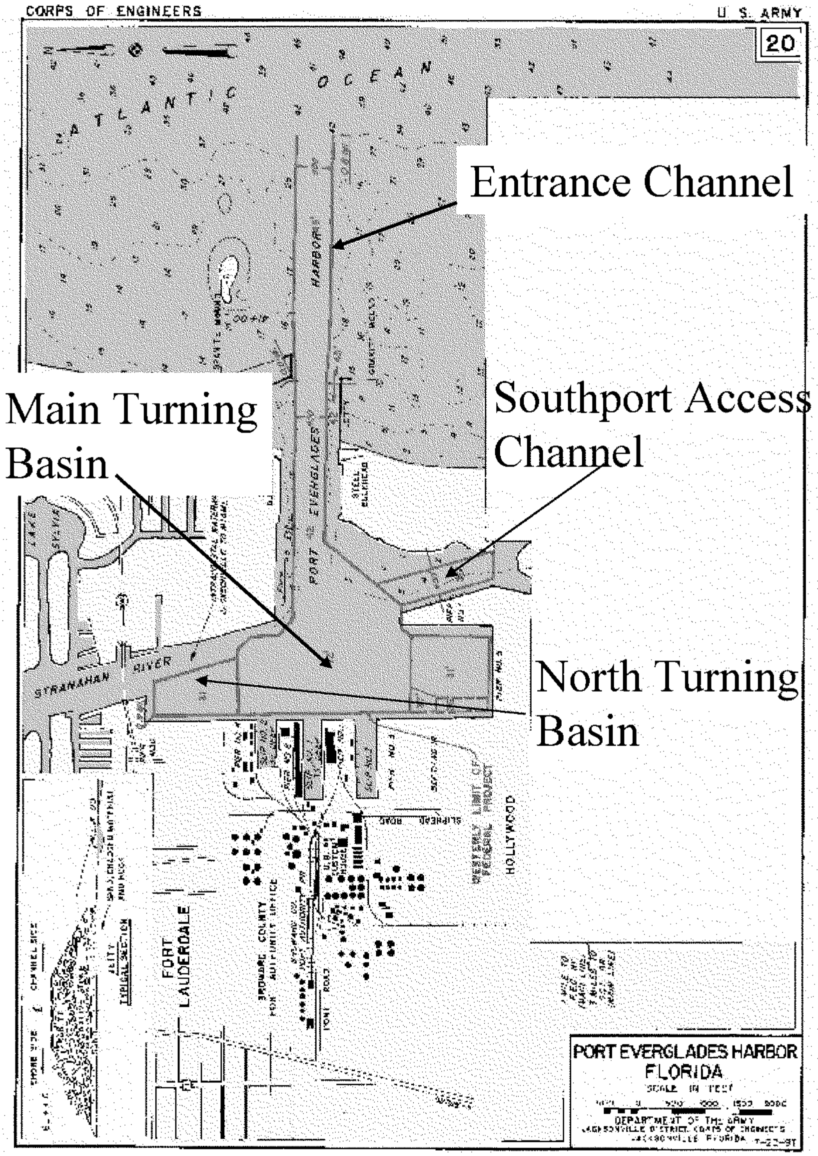
Description of the Proposed Action

The U.S. Army Corps of Engineers (Corps) proposes to expand and deepen Port Everglades Harbor. A detailed description of the proposed project and all alternatives considered under the Feasibility Study are evaluated in the pending Draft Environmental Impact Statement. Broward County Port Department requested that the Corps study the feasibility of widening and deepening most of the major channels and basins within Port Everglades. Four major improvement goals were identified. 1) Improve transit in the Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB) and Southport Access Channel (SAC) to accommodate liquid bulk, cruise, and container vessels; 2) Develop the Dania Cutoff Canal (DCC) to accommodate mid-size vessels; 3) Deepen the North Turning Basin to accommodate Panamax size container ships; and 4) Improve turning and berthing in the Turning Notch (Figure 1).

The purpose of the proposed action is to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment. The proposed action resulted from a comprehensive analysis of all the existing and future commercial vessel transit needs within the port. This economic analysis has shown that improvements to most of the major Federal and non-Federal channels and basins are required to achieve efficient transit of the existing fleet, and to accommodate the future fleet. Substantial liquid bulk cargo cost savings can be achieved by deepening the OEC, IEC, and MTB. Widening of the OEC flare will allow safer transit for all the larger commercial vessels that experience sometimes troublesome cross currents at the channel entrance. Removal of the Widener Shoal and widening of the SAC allows for more efficient and safer transits of containerized cargo vessels past the Knuckles restriction where new generation cruise vessels are expected to be berthed. Lengthening and deepening of the TN will provide turning possibilities for larger vessels and will provide critical berthing for containerized cargo vessels. Deepening of the STB will allow for more efficient use Berths 16-18 by allowing Panamax vessel calls. Finally, widening and deepening of the DCC (in addition to a turning basin located adjacent to the SAC) will allow for relocation of smaller and midsize container, roll on/roll off (ro/ro) vessels, and general cargo traffic, thereby reducing congestion in the areas serviced by larger vessels.

The Corps expects the construction to be performed using a variety of methods including blasting and dredging with a cutterhead, clamshell, hopper or other type of dredge. Any blasting that will occur within the project will be confined blasting. Confined blasting is defined as a blast where the explosives had been placed in a hole bored into the rock substrate and capped with 3-4 feet of crushed rock known as “stemming”. Stemming forces the explosive blast downward into the rock instead of allowing the blast to expand into the water column.

Fig 1 – Port Everglades Federal Navigation Project



Action Area
The Port Everglades Harbor is the second largest seaport located on the east coast of Florida. The Harbor lies adjacent to cities of Dania and Fort Lauderdale (Broward County), with immediate access to the Atlantic Ocean and the Intracoastal Waterway. The entrance of the Port is approximately 27 nautical miles north of Miami Harbor, Florida and 301 nautical miles south of Jacksonville Harbor, Florida. Figure 2 shows major features located within and surrounding the project site.

Protected Species Included in this Assessment
The Corps has determined the that the following listed species under NMFS jurisdiction occur in the action area: green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), Hawksbill sea turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), Johnson's seagrass (*Halophila johnsonii*), blue (*Balenoptera musculus*), humpback, (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), fin (*Balenoptera physalus*) and sperm (*Physeter macrocephalus*) whales and smalltooth sawfish (*Pristis pectinata*). The Corps has relied heavily upon the Surtass LFA Biological Opinion that was completed by NMFS on May 31, 2002 for biological information concerning the biology, life history and status for the large whale species discussed in this assessment. This document was accessed from the NMFS website at:
http://www.nmfs.noaa.gov/prot_res/readingrm/ESAsec7/7pr_surtass-2020529.pdf.

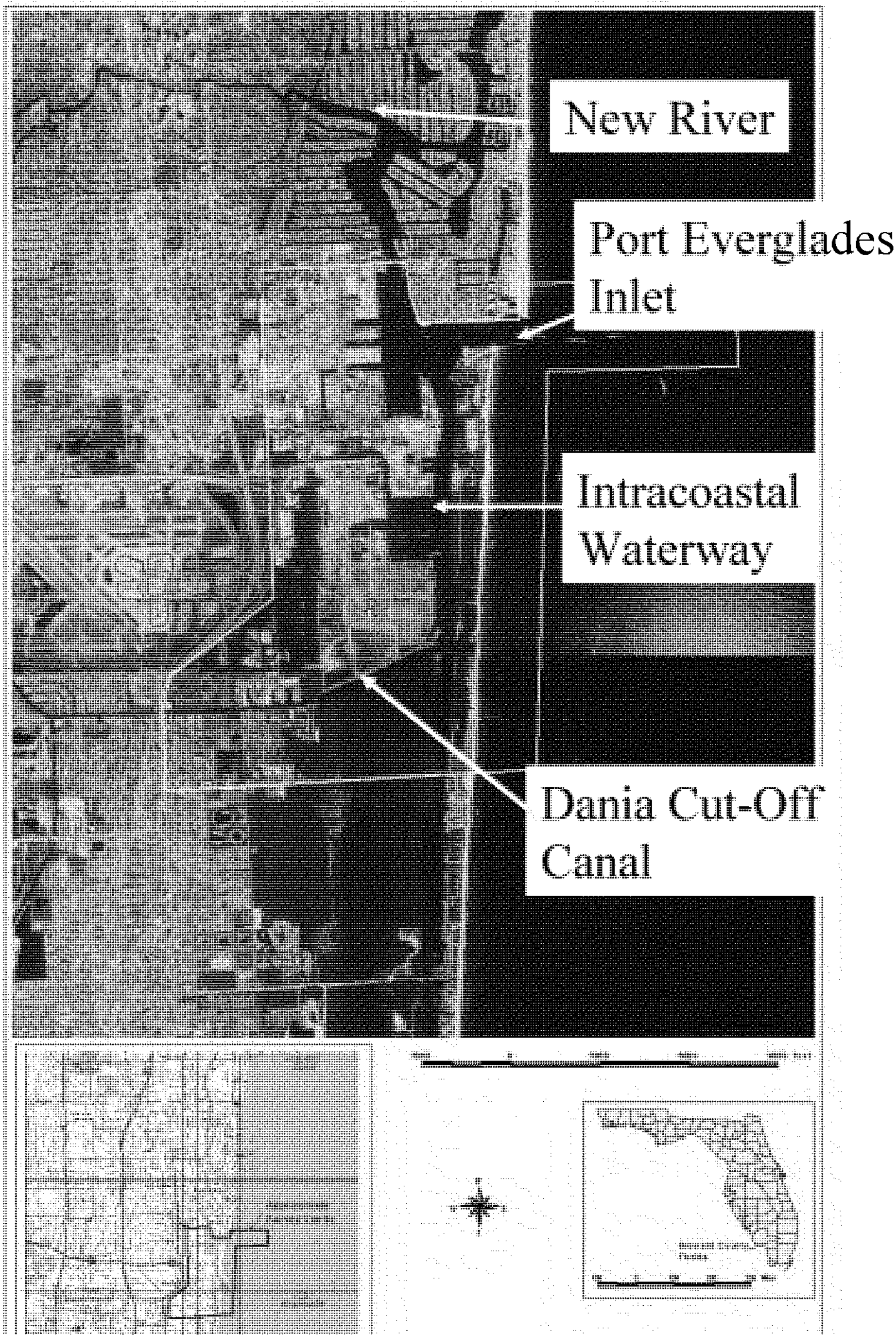
The Corps has reviewed the biological, status, threats and distribution information presented in this assessment and believes that the following species will be in or near the action area and thus may be affected by the proposed project: the five sea turtle species; humpback and sperm whales, Johnson's seagrass and smalltooth sawfish.

Six species of endangered marine mammals may be found seasonally in the waters offshore southeastern Florida. The Corps believes that only the sperm and humpback whales may be adversely affected by activities associated with the proposed action. These effects would be a result of acoustic harassment.

The blue, fin, northern right and sei whales are not discussed in detail because they are unlikely to be within the vicinity of the project. Additional information on blue, fin and sei whales can be found in Waring *et al.* (1999). Due to the rarity of sightings of these four whale species near the project area, the Corps believes that any effects to them by the project are discountable. Discountable effects under Section 7 of the ESA are those "extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur."

The endangered Florida manatee (*Trichecus manatus*) and the American crocodile (*Crocodylus acutus*) also occur with the action area and the Corps has initiated consultation with the U.S. Fish and Wildlife Service concerning the effects of the proposed action on these species.

Fig 2 – Location Map and Plan View



Status and Distribution of the Species

Green Turtle (*Chelonia mydas*)

Distribution. Green turtles are distributed circumglobally. In the western Atlantic they range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean, but are considered rare north of Cape Hatteras (Wynne and Schwartz, 1999). Several major nesting assemblages have been identified and studied in the western Atlantic (Peters 1954; Carr and Ogren, 1960; Carr *et al.*, 1978). Most green turtle nesting in the continental United States occurs on the Atlantic Coast of Florida (Ehrhart 1979). Green turtles are the largest of the hard-shelled sea turtles. Adult male green turtles are smaller than adult females whose lengths range from 92 to 110 cm (36 to 43 in.) and weights range from 119 to 182 kg (200 to 300 lbs). Their heads are small compared to other sea turtles and the biting edge of their lower jaws is serrated.

Green turtles have a more tropical distribution than loggerhead turtles; they are generally found in waters between the northern and southern 20°C isotherms (Hirth 1971). Green turtles, like most other sea turtles, are distributed more widely in the summer when warmer water temperatures allow them to migrate north along the Atlantic coast of North America. In the summer, green turtles are found around the U.S. Virgin Islands, Puerto Rico, and continental North America from Texas to Massachusetts. Immature greens can be distributed in estuarine and coastal waters from Long Island Sound, Chesapeake Bay, and the North Carolina sounds south throughout the tropics (Musick and Limpus, 1997). In the United States, green turtles nest primarily along the Atlantic Coast of Florida, the U.S. Virgin Islands, and Puerto Rico. In the winter, as water temperatures decline, green turtles that are found north of Florida begin to migrate south into subtropical and tropical water.

Status and Population Trends. The green turtle was protected under the ESA in 1978; breeding populations off the coast of Florida and the Pacific coast of Mexico are listed as endangered, all other populations are listed as threatened. Recent population estimates for the western Atlantic area are not available. However, there is evidence that green turtle nesting has been on the increase during the past decade. Recently, green turtle nesting occurred on Bald Head Island, North Carolina just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. Increased nesting has also been observed along the Atlantic Coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Certain Florida nesting beaches where most green turtle nesting activity occurs have been designated index beaches. Index beaches were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the six years of regular monitoring since establishment of the index beaches in 1989. A nesting summary for the county in which the proposed project resides is found in Table 1.

Table 1: Summary of Green Turtle (*Chelonia mydas*) Nesting in Broward County, 1988-2003

Year	Beach Length (km)	Number of Nests	Number of Non-Nesting Emergences	Date of First Nest	Date of Last Nest
1988	38.4	35	25	5/27/88	6/29/88
1989	42.1	30	24	6/2/89	8/17/89
1990	38.3	106	82	5/13/90	9/12/90
1991	38.6	11	25	6/12/91	9/4/91
1992	41.3	132	205	6/6/92	9/5/92

1993	42.5	31	25	6/30/93	9/3/93
1994	42.5	123	189	6/2/94	9/10/94
1995	37.4	52	97	5/12/95	9/13/95
1996	42.5	130	188	5/31/96	9/11/96
1997	42.5	29	48	5/24/97	9/10/97
1998	42.5	200	265	5/30/98	9/6/98
1999	38.6	24	32	5/24/99	9/3/99
2000	38.6	255	394	5/17/00	9/3/00
2001	38.6	26	48	3/16/01	8/4/01
2002	38.6	216	342	5/16/02	9/26/02
2003	28.6	78	49	5/30/03	9/28/03

Source: Florida Marine Research Institute. 2004

Natural History. While nesting activity is obviously important in determining population distributions, the remaining portion of the green turtle's life is spent on the foraging grounds. Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida, the northwestern coast of the Yucatan Peninsula, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach. Pelagic juveniles are assumed to be omnivorous, but with a strong tendency toward carnivory during early life stages. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas, shifting to a chiefly herbivorous diet (Bjorndal 1997). Post-pelagic green turtles feed primarily on sea grasses and benthic algae but also consume jellyfish, salps, and sponges. In the western Atlantic region, the summer developmental habitat encompasses estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and North Carolina sounds, and south throughout the tropics (Musick and Limpus, 1997). Like loggerheads and Kemp's ridleys, green sea turtles that use northern waters during the summer must return to southern waters in autumn, or face the risk of cold stunning.

Threats. The greatest threat to this species is the loss of its nesting habitat. Throughout the tropical and subtropical distribution of this species, beaches are eroded, armored, renourished, or converted for residential or commercial purposes. Green turtles are also threatened by fibropapilloma disease; incidental takes in commercial or recreational fishing gear; and poaching (although poaching is infrequent in the United States). Green turtles are harvested in some nations for food, leather, and jewelry. Green turtles are also threatened by natural causes including hurricanes; predation by fire ants, raccoons, and opossums; and poaching of eggs and nesting females.

Anthropogenic impacts to the green turtle population are similar to those for other sea turtle species. Sea sampling coverage in the pelagic driftnet, pelagic longline, scallop dredge, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles. In addition, the NMFS/Northeast Fisheries Science Center (NEFSC) is conducting a review of bycatch levels and patterns in all fisheries in the western Atlantic for which observer data is available. Bycatch estimates will be made for all fisheries for which sample sizes are sufficiently large to permit reasonable statistical analysis. This will be compiled into an assessment report. Until that analysis is completed, the only information on the magnitude of takes available for fisheries in the action area are unextrapolated numbers of observed takes from the sea sampling data. Preliminary sea sampling data summary (1994-1998) shows the following total take of green turtles: one (anchored gillnet), two (pelagic driftnet), and two (pelagic longline). Stranding reports indicate that between 200-300 green turtles strand annually from a variety of causes (Sea Turtle Stranding and Salvage Network, unpublished data). As with the other species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of other mortality.

Critical Habitat. In 1998, NMFS designated the waters surrounding the islands of Culebra, Puerto Rico as critical habitat for the green turtle. This area supports major seagrass beds and reefs that provide forage and shelter habitat. The action area does not comprise critical habitat for green turtles.

Loggerhead Turtle

Distribution. Loggerhead turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans and are the most abundant species of sea turtle occurring in U.S. waters. Loggerheads concentrate their nesting in the north and south temperate zones and subtropics, but generally avoid nesting in tropical areas of Central America, northern South America, and the Old World (NRC 1990). The largest known nesting aggregation of loggerhead turtles occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani, 1982). In the western Atlantic, most loggerhead turtles nest from North Carolina to Florida and along the gulf coast of Florida. The best scientific and commercial data available on the genetics of loggerhead turtles suggests there are four major subpopulations of loggerheads in the northwest Atlantic: (1) a northern nesting subpopulation that occurs from North Carolina to northeast Florida, about 29° N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); and (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez 1990) (approximately 1,000 nests in 1998, according to TEWG, 2000). This biological assessment will focus on the northwest Atlantic subpopulations of loggerhead turtles, which occur in the action area. A nesting summary for the county in which the action is proposed is included in Table 2.

Table 2: Summary of Loggerhead (*Caretta caretta*) Nesting in Broward County, 1988-2003

Year	Beach Length (km)	Number of Nests	Number of Non-Nesting Emergences	Date of First Nest	Date of Last Nest
1988	38.4	1349	2509	5/1/88	8/28/88
1989	42.1	1791	1547	4/20/89	9/8/89
1990	38.3	2283	1928	4/22/90	9/12/90
1991	38.6	2033	1923	4/23/91	9/3/91
1992	41.3	2230	1978	4/23/92	9/2/92
1993	42.5	2267	2071	4/29/93	9/15/93
1994	42.5	2180	2306	4/23/94	9/4/94
1995	37.9	2567	2330	4/25/95	9/12/95
1996	38.6	2902	3235	4/23/96	9/7/96
1997	38.6	2216	2382	4/18/97	9/8/97
1998	38.6	2643	4065	4/23/98	9/13/98
1999	38.6	2584	3025	4/18/99	8/29/99
2000	38.6	2674	3121	4/18/00	9/9/00
2001	38.6	2321	2327	4/20/01	8/28/01
2002	38.6	2070	2361	4/12/02	9/10/02
2003	38.6	2335	2746	4/17/03	8/28/03

source: Florida Marine Research Institute. 2004

Although NMFS and FWS have not completed the administrative processes necessary to formally recognize populations or subpopulations of loggerhead turtles, these sea turtles are generally grouped by nesting locations. Based on the most recent reviews of the best scientific and commercial data on the population genetics of loggerhead sea turtles and analyses of their population trends (TEWG, 1998; TEWG 2000), NMFS and FWS treat these loggerhead turtle nesting aggregations as distinct subpopulations whose survival and recovery is critical to the survival and recovery of the species. Further, any action that appreciably reduced the likelihood that one or more of these nesting aggregations would survive and recover would appreciably reduce the species' likelihood of survival and recovery in the wild. Consequently, this biological opinion will focus on the four nesting aggregations of loggerhead turtles identified in the preceding paragraph (which occur in the action area) and treat them as subpopulations for the purposes of this analysis. Natal homing to the nesting beach provides the genetic barrier between these subpopulations, preventing recolonization from turtles from other nesting beaches. The importance of maintaining these subpopulations in the wild is shown by the many examples of extirpated nesting assemblages in the world. In addition, recent fine-scale analysis of mtDNA work from Florida rookeries indicate that population separations begin to appear between nesting beaches separated by more than 50-100 km of coastline that does not host nesting (Francisco *et al.* 2000) and tagging studies are consistent with this result (Richardson 1982, Ehrhart 1979, LeBuff 1990, CMTTP: in NMFS SEFSC 2001). Nest site relocations greater than 100 km occur, but generally are rare (Ehrhart 1979; LeBuff 1974, 1990; CMTTP; Bjorndal *et al.* 1983: *in* NMFS SEFSC 2001).

The loggerhead turtles in the action area are likely to represent differing proportions of the four western Atlantic subpopulations. Although the northern nesting subpopulation produces about 9% of the loggerhead nests, they comprise more of the loggerhead sea turtles found in foraging areas from the northeastern U.S. to Georgia: between 25 and 59 percent of the loggerhead turtles in this area are from the northern subpopulation (NMFS SEFSC 2001; Bass *et al.*, 1998; Norrgard, 1995; Rankin-Baransky, 1997; Sears 1994, Sears *et al.*, 1995). In the Carolinas, the northern subpopulation is estimated to make up from 25% to 28% of the loggerheads (NMFS SEFSC 2001; Bass *et al.* 1998, 1999). About ten percent of the loggerhead turtles in foraging areas off the Atlantic coast of central Florida are from the northern subpopulation (Witzell *et al.*, in prep). In the Gulf of Mexico, most of the loggerhead turtles in foraging areas will be from the South Florida subpopulation, although the northern subpopulation may represent about 10% of the loggerhead sea turtles in the Gulf (Bass pers. comm). In the Mediterranean Sea, about 45 - 47 percent of the pelagic loggerheads are from the South Florida subpopulation and about two percent are from the northern subpopulation, while only about 51% originated from Mediterranean nesting beaches (Laurent *et al.*, 1998). In the vicinity of the Azores and Madiera Archipelagoes, about 19% of the pelagic loggerheads are from the northern subpopulation, about 71% are from the South Florida subpopulation, and about 11% are from the Yucatán subpopulation (Bolten *et al.*, 1998).

Natural History. Loggerhead turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years. Turtles in this life history stage are called "pelagic immatures" and are best known from the eastern Atlantic near the Azores and Madeira and have been reported from the Mediterranean as well as the eastern Caribbean (Bjorndal *et al.*, in press). Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm SCL they recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico.

Benthic immatures have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico (R. Márquez-M., pers. comm.). Large benthic immature loggerheads (70-91 cm) represent a larger proportion of the strandings and in-water captures (Schroeder *et al.*, 1998) along the south and western coasts of Florida as compared with the rest of the coast, but it is not known whether the larger animals actually are more abundant in these areas or just more abundant within the area relative to the smaller turtles. Benthic immature loggerheads foraging in northeastern U.S. waters are known to migrate southward in the fall as water temperatures cool (Epperly *et al.*, 1995; Keinath, 1993; Morreale and Standora, 1999; Shoop and Kenney, 1992), and migrate northward in spring. Given an estimated age at maturity of 21-35 years (Frazer and Ehrhart, 1985; Frazer and Limpus, 1998), the benthic immature stage must be at least 10-25 years long. NMFS SEFSC 2001 analyses conclude that juvenile stages have the highest elasticity and maintaining or decreasing current sources of mortality in those stages will have the greatest impact on maintaining or increasing population growth rates.

Like other sea turtles, the movements of loggerheads are influenced by water temperature. Since they are limited by water temperatures, sea turtles do not usually appear on the summer foraging grounds until June, but are found in Virginia as early as April. The large majority leaves the Gulf of Maine by mid-September but may remain in these areas until as late as November and December. Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks (Wynne and Schwartz, 1999). Under certain conditions they may also scavenge fish, particularly if they are easy to catch (e.g., caught in nets) (NMFS and USFWS, 1991).

Adult female loggerheads in the western Atlantic come ashore to nest primarily from North Carolina southward to Florida. Additional nesting assemblages occur in the Florida Panhandle and on the Yucatán Peninsula. Non-nesting, adult female loggerheads are reported throughout the U.S. and Caribbean Sea; however, little is known about the distribution of adult males who are seasonally abundant near nesting beaches during the nesting season. Aerial surveys suggest that loggerheads (benthic immatures and adults) in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Threats. Loggerhead sea turtles face a number of human-related threats in the marine environment, including oil and gas exploration, development, and transportation; marine pollution; trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries (see below); underwater explosions; dredging, offshore artificial lighting; power plant entrapment; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; and poaching.

Although loggerhead turtles are most vulnerable to pelagic longlines during their pelagic, immature life history stage, there is some evidence that benthic immatures may also be captured, injured, or killed by pelagic fishery operations. Recent studies have suggested that not all loggerhead turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic immatures, followed by permanent settlement into benthic environments. Some may not totally circumnavigate the North Atlantic. In addition, some of these turtles may either remain in the pelagic habitat in the North Atlantic longer than hypothesized or they may move back and forth between pelagic and coastal habitats (Witzell in prep.). Any loggerhead turtles that follow this developmental model would be adversely affected by shark gill nets and shark bottom longlines set in coastal waters, in addition to pelagic longlines.

On their nesting beaches in the U.S., loggerhead turtles are threatened with beach erosion, armoring, and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; exotic dune and beach vegetation; predation by fire ants, raccoons, armadillos, opossums; and poaching. Elimination/control of these threats are especially important because, from a global perspective, the southeastern U.S. nesting aggregation is critical to the survival of this species: it is second in size only to the nesting aggregations in the Arabian Sea off Oman and represents about 35 and 40 percent of the nests of this species. The status of the Oman nesting beaches has not been evaluated recently, but they are located in a part of the world that is vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills), the resulting risk facing this nesting aggregation and these nesting beaches is cause for considerable concern (Meylan *et al.*, 1995).

Loggerhead turtles also face numerous threats from weather and coastal processes. For example, there is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November) and loggerhead turtle nesting season (March to November); hurricanes can have potentially disastrous effects on the survival of eggs in sea turtle nests. In 1992, Hurricane Andrew affected turtle nests over a 90-mile length of coastal Florida; all of the eggs were destroyed by storm surges on beaches that were closest to the eye of this hurricane (Milton *et al.*, 1992). On Fisher Island near Miami, Florida, 69% of the eggs did not hatch after Hurricane Andrew, probably because they were drowned by the storm surge. Nests from the northern subpopulation were destroyed by hurricanes, which made landfall in North Carolina in the mid to late 1990's. Sand accretion and rainfall that result from these storms can appreciably reduce hatchling success. The recent landfall of Hurricane Charley on Florida's southwest coast and the impending landfall of Hurricane Frances will also have adverse effects on nest success. These natural phenomena probably have significant, adverse effects on the size of specific year classes; particularly given the increasing frequency and intensity of hurricanes in the Caribbean Sea and northwest Atlantic Ocean.

Status and Population Trends. The loggerhead turtle was listed as threatened under the ESA on July 28, 1978. The most recent work updating what is known regarding status and trends of loggerhead sea turtles is contained in NMFS SEFSC 2001. The recovery plan for this species (NMFS and USFWS 1991) state that southeastern U.S. loggerheads can be considered for delisting if, over a period of 25 years, adult female populations in Florida are increasing and there is a return to pre-listing annual nest numbers totaling 12,800 for North Carolina, South Carolina, and Georgia combined. This equates to approximately 3,100 nesting females per year at 4.1 nests per female per season. NMFS SEFSC 2001 concludes, "…nesting trends indicate that the numbers of females associated with the South Florida subpopulation are increasing. Likewise, nesting trend analyses indicate potentially increasing nest numbers in the northern subpopulation" (TEWG 2000). However, NMFS SEFSC 2001 also cautions that given the uncertainties in survival rates (of the different life stages, particularly the pelagic immature stage), and the stochastic nature of populations, population trajectories should not be used now to quantitatively assess when the northern subpopulation may achieve 3,100 nesting females.

Several published reports have presented the problems facing long-lived species that delay sexual maturity in a world replete with threats from a modern, human population (Crouse *et al.*, 1987, Crowder *et al.*, 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high, annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes. This general tenet of population ecology originated in studies of sea turtles (Crouse *et al.*, 1987, Crowder *et al.*, 1994, Crouse 1999). Heppell *et al.* (in prep.) specifically showed that the growth of the loggerhead sea turtle population was particularly sensitive to changes in the annual survival of both juvenile and adult sea turtles and that the adverse effects of the pelagic longline fishery on loggerheads from the pelagic immature phase appeared critical to the survival and recovery of the species. Crouse (1999) concluded that relatively small changes in annual survival rates of both juvenile and adult loggerhead sea turtles would adversely affect large segments of the total loggerhead sea turtle population.

The four major subpopulations of loggerhead sea turtles in the northwest Atlantic, northern, south Florida, Florida panhandle, and Yucatán are all subject to fluctuations in the number of young produced annually because of natural phenomena like hurricanes as well as human-related activities. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast (in areas like Merrit Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection and probably cause fluctuations in sea turtle nesting success. Sea turtles nesting in the southern and central counties of Florida can be affected by beach armoring, beach renourishment, beach cleaning, artificial lighting, predation, and poaching (NMFS & FWS 1991).

As discussed previously, the survival of juvenile loggerhead sea turtles is threatened by a completely different set of threats from human activity once they migrate to the ocean. Pelagic immature loggerhead sea turtles from these four subpopulations circumnavigate the North Atlantic over several years (Carr 1987, Bjorndal 1994). During that period, they are exposed to a series of long-line fisheries that include an Azorean long-line fleet, a Spanish long-line fleet, and various fleets in the Mediterranean Sea (Aguilar *et al.*, 1995, Bolten *et al.,* 1994, Crouse 1999). Based on their proportional distribution, the capture of immature loggerhead sea turtles in long-line fleets in the Azores and Madiera Archipelagoes and the Mediterranean Sea will have a significant, adverse effect on the annual survival rates of juvenile loggerhead sea turtles from the western Atlantic subpopulations, with a disproportionately large effect on the northern subpopulation that may be significant at the population level.

In waters off coastal U.S., a suite of fisheries in Federal and State waters threatens the survival of juvenile loggerhead sea turtles. Loggerhead turtles are captured, injured, or killed in shrimp fisheries off the Atlantic coast; along the southeastern Atlantic coast, loggerhead turtle populations are declining where shrimp fishing is intense off the nesting beaches (NRC 1990). Conversely these nesting populations do not appear to be declining where nearshore shrimping effort is low or absent. The management of shrimp harvest in the Gulf of Mexico demonstrates the correlation between shrimp trawling and impacts to sea turtles. Waters out to 200nm are closed to shrimp fishing off of Texas each year for approximately a three-month period (mid-May through mid-July) to allow shrimp to migrate out of estuarine waters; sea turtle strandings decline dramatically during this period (NMFS, STSSN unpublished data). Loggerhead sea turtles are captured in fixed pound-net gear in the Long Island Sound, in pound-net gear and trawls in summer flounder and other finfish fisheries in the mid-Atlantic and Chesapeake Bay, in gill net fisheries in the mid-Atlantic and elsewhere, in fisheries for monkfish and for spiny dogfish, and in northeast sink gillnet fisheries (see further discussion in the *Environmental Baseline* of this Opinion). Witzell (1999) compiled data on capture rates of loggerhead and leatherback turtles in U.S. longline fisheries in the Caribbean and northwest Atlantic; the cumulative takes of these fisheries approach those of the U.S. shrimp fishing fleet (Crouse 1999, NRC 1990).

Based on the data available, it is not possible to estimate the size of the loggerhead population in the U.S. or its territorial waters. There is, however, general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage. Nesting data collected on index nesting beaches in the U.S. from 1989-1998 represent the best dataset available to index the population size of loggerhead turtles. However, an important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates. Given this, between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,016-89,034 annually, representing, on average, an adult female population of 44,780 [(nests/4.1) * 2.5]. On average, 90.7% of the nests were from the South Florida subpopulation, 8.5% were from the northern subpopulation, and 0.8% were from the Florida Panhandle subpopulation. There is limited nesting throughout the Gulf of Mexico west of Florida, but it is not known to what subpopulation they belong. Based on the above, there are only an estimated 3,800 nesting females in the northern loggerhead subpopulation. The status of this population, based on number of loggerhead nests, has been classified as stable or declining

(TEWG 2000). Another consideration adding to the vulnerability of the northern subpopulation is that NMFS scientists estimate, using genetics data from Texas, South Carolina, and North Carolina in combination with juvenile sex ratios from those states, that the northern subpopulation produces 65% males, while the Florida subpopulation is estimated to produce 80% females (NMFS SEFSC 2001, Part I).

Critical Habitat. No critical habitat has been designated for loggerhead turtles.

Leatherback Turtle (Dermochelys coriacea)

Distribution. The leatherback is the largest living turtle. Leatherback sea turtles are widely distributed throughout the oceans of the world, and are found throughout waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972).

Leatherback turtles undertake the longest migrations of any other sea turtle and exhibit the broadest thermal tolerances (NMFS and USFWS 1998). Leatherback turtles are able to inhabit intensely cold waters for a prolonged period of time because leatherbacks are able to maintain body temperatures several degrees above ambient temperatures. Leatherback turtles are typically associated with continental shelf habitats and pelagic environments, and are sighted regularly in offshore waters (>328 ft). Leatherback turtles regularly occur in deep waters (>328 ft), and an aerial survey study in the north Atlantic Ocean sighted leatherback turtles in water depths ranging from 3 to 13,618 ft, with a median sighting depth of 131.6 ft (CeTAP 1982). This same study found leatherbacks in waters ranging from 7 to 27.2°C.

Natural History. Although leatherbacks are a long lived species (> 30 years), they are somewhat faster to mature than loggerheads, with an estimated age at sexual maturity reported as about 13-14 years for females, and an estimated minimum age at sexual maturity of 5-6 years, with 9 years reported as a likely minimum (Zug and Parham 1996).

Leatherback sea turtles are predominantly distributed pelagically where they feed on jellyfish such as *Stomolophus, Chryaora,* and *Aurelia* (Rebel 1974). Leatherbacks are deep divers, with recorded dives to depths in excess of 1000 m, but they may come into shallow waters if there is an abundance of jellyfish nearshore. They also occur annually in places such as Cape Cod and Narragansett bays during certain times of the year, particularly the fall.

Status and Threats. The leatherback was listed as endangered on June 2, 1970 and a recovery plan was issued in 1998. Leatherback turtles are included in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, which effectively bans trade.

Globally, leatherback turtle populations have been decimated worldwide. The global leatherback turtle population was estimated to number approximately 115,000 adult females in 1980 (Pritchard 1982), but only 34,500 in 1995 (Spotila *et al.* 1996). The decline can be attributed to many factors including fisheries as well as intense exploitation of the eggs (Ross 1979). On some beaches nearly 100% of the eggs laid have been harvested (Eckert 1996). Eckert (1996) and Spotila *et al.* (1996) record that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries.

The status of the Atlantic population is not clear. In 1996, it was reported to be stable, at best (Spotila 1996), but numbers in the Western Atlantic at that writing were reported to be on the order of 18,800 nesting females. According to Spotila (pers. com.), the Western Atlantic population currently numbers about 15,000 nesting females, whereas current estimates for the Caribbean (4,000) and the Eastern Atlantic (i.e. off Africa, numbering ~ 4,700) have remained consistent with numbers reported by Spotila *et al.* in 1996. Between 1989 and 1995, marked leatherback returns to the nesting beach at St. Croix averaged only 48.5%, but that the overall nesting population grew (McDonald, et. al 1993). This is in contrast to a Pacific nesting beach at Playa Grande, Costa Rica, where only 11.9% of turtles tagged in 1993-94 and 19.0% of turtles tagged in 1994-95 returned to nest over the next five years. Characterizations of this population suggest that it has a very low likelihood of survival and recovery in the wild under current conditions.

Spotila *et al.* (1996) describe a hypothetical life table model based on estimated ages of sexual maturity at both ends of the species= natural range (5 and 15 years). The model concluded that leatherbacks maturing in 5 years would exhibit much greater population fluctuations in response to external factors than would turtles that mature in 15 years. Furthermore, the simulations indicated that leatherbacks could maintain a stable population only if both juvenile and adult survivorship remained high, and that if other life history stages (i.e. egg, hatchling, and juvenile) remained static, stable leatherback populations could not withstand an increase in adult mortality above natural background levels without decreasing.

The primary threats to leatherback turtles are entanglement in fishing gear (e.g., gillnets, longlines, lobster pots, weirs), boat collisions, and ingestion of marine debris (NMFS and USFWS 1997). The foremost threat is the number of leatherback turtles killed or injured in fisheries. Spotila (2000) states that a conservative estimate of annual leatherback fishery-related mortality (from longlines, trawls and gillnets) in the Pacific during the 1990s is 1,500 animals. He estimates that this represented about a 23% mortality rate (or 33% if most mortality was focused on the East Pacific population). As noted above, leatherbacks normally live at least 30 years, usually maturing at about 12-13 years. Such long-lived species cannot withstand such high rates of anthropogenic mortality.

Table 3: Summary of Leatherback (*Dermochelys coriacea*) Nesting in Broward County, 1988-2003

Year	Beach Length (km)	Number of Nests	Number of Non-Nesting Emergences	Date of First Nest	Date of Last Nest
1988	38.4	4	0	5/12/88	6/1/88
1989	42.1	4	2	4/24/89	5/19/89
1990	38.3	1	2	5/9/90	5/9/90
1991	38.6	4	1	4/1/91	5/28/91
1992	41.3	7	6	4/15/92	6/16/92
1993	42.5	17	4	4/6/93	6/19/93
1994	42.5	9	0	3/24/94	5/28/94
1995	37.9	15	5	3/16/95	6/29/95
1996	38.6	2	0	5/8/96	6/3/96
1997	38.6	41	10	2/28/97	6/19/97
1998	38.6	14	8	4/26/98	6/11/98
1999	38.6	12	2	3/11/99	5/26/99

2000	38.6	13	4	5/5/00	6/3/00
2001	38.6	39	7	4/20/01	8/21/01
2002	38.6	18	7	3/2/02	6/22/02
2003	38.6	12	3	3/19/03	5/10/03

source: Florida Marine Research Institute. 2004

Critical Habitat. NMFS and FWS designated certain areas of the US Virgin Islands as critical habitat for the leatherback turtle. The action area does not comprise designated critical habitat for the species.

Hawksbill Turtle

Distribution. Hawksbill turtles occur in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. Recognized subspecies occupy the Atlantic Ocean (ssp. *imbricata*) and the Pacific Ocean (ssp. *squamata*). Richardson *et al.* (1989) estimated that the Caribbean and Atlantic portions of the U.S. support a minimum of 650 hawksbill turtle nests each year. In the United States, hawksbill turtles have been recorded in all states along the Gulf of Mexico and along the Atlantic coast from Florida to Massachusetts. United States populations nest primarily in the U.S. Virgin Islands and Puerto Rico, but occasionally on the Atlantic coast of Florida. Two hawksbill turtle carcasses have been found in the vicinity of the action area (Wendy Teas, pers com, 2002, NMFS - SEFSC Miami Laboratory).

Natural History. Hawksbill turtles use different habitats for different stages in their life cycles. Post-hatchling hawksbill turtles remain in pelagic environments to take shelter in weedlines that accumulate at convergence points. Juvenile hawksbill turtles (those with carapace lengths of 20-25 cm) re-enter coastal waters where they become residents of coral reefs, which provide sponges for food and ledges, and caves for shelter. Hawksbill turtles are also found around rocky outcrops, high-energy shoals, and mangrove-fringed bays and estuaries (particularly in areas where coral reefs do not occur). Hawksbill turtles remain in coastal waters when they become subadults and adults.

Status and Threats. The hawksbill turtle was listed as an endangered species on June 2, 1970 (35 FR 8491). Populations are threatened by significant modifications of its coastal habitat throughout its range. The National Research Council (1990), and NMFS/FWS (1993) have published general overviews of the effects of habitat alteration on hawksbill turtles. In the U.S. Virgin Islands, problems such as egg poaching, domestic animals, beach driving, litter, and recreational use of beaches have presented problems for nesting hawksbill turtles. In addition, beachfront lights appear to pose a serious problem for hatchling hawksbill (and other) turtles in the U.S. Virgin Islands. At sea, activities that damage coral reefs and other habitats that are important to the hawksbill turtle threaten the continued existence of this species. Hawksbill turtles are also threatened by stochastic events (e.g., hurricanes); predation by fire ants, raccoons and opossums; and by poaching of eggs and nesting females by humans.

Critical Habitat. In 1998, NMFS designated the waters surrounding Mona and Monito Islands, Puerto Rico as critical habitat for the hawksbill turtle. The action area does not comprise designated critical habitat for the species.

Kemp's Ridley Sea Turtle

Status and Population Trends. Of the seven extant species of sea turtles of the world, the Kemp's ridley has declined to the lowest population level. The Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempi*) (USFWS and NMFS 1992) contains a description of the natural history, taxonomy, and distribution of the Kemp's ridley turtle. Kemp's ridleys nest in daytime aggregations known as *arribadas*. The primary arribada in the Gulf of Mexico is at Rancho Nuevo, a stretch of beach in Mexico. Most of the population of adult females nest in this single locality (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the early 1970's, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid-1980s. Recent observations of increased nesting suggest that the decline in the ridley population has stopped and there is cautious optimism that the population is now increasing.

After unprecedented numbers of Kemp's ridley carcasses were reported from Texas and Louisiana beaches during periods of high levels of shrimping effort, NMFS established a team of population biologists, sea turtle scientists, and managers, known as the Turtle Expert Working Group (TEWG) to conduct a status assessment of sea turtle populations. Analyses conducted by the group have indicated that the Kemp's ridley population is in the early stages of recovery; however, strandings in some years have increased at rates higher than the rate of increase in the Kemp's population (TEWG 1998).

The TEWG (1998) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the TEWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20-60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the U.S. Fish and Wildlife Service (FWS) and Mexico's Instituto Nacional de Pesca to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of turtle excluder devices (TEDs). Adult ridley numbers have now grown from a low of approximately 1,050 adults producing 702 nests in 1985, to greater than 3,000 adults producing 1,940 nests in 1995 and about 3,400 nests in 1999.

The TEWG (1998) was unable to estimate the total population size and current mortality rates for the Kemp's ridley population. However, the TEWG listed a number of preliminary conclusions. The TEWG indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Over the period 1987 to 1995, the rate of increase in the annual number of nests accelerated in a trend that would continue with enhanced hatchling production and the use of TEDs. Nesting data indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and a low of 702 nests in 1985. This trajectory of adult abundance tracks with trends in nest abundance from an estimate of 9,600 in 1966 to 1,050 in 1985. The TEWG estimated that in 1995 there were 3,000 adult ridleys. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6% to 28% from 1981 to 1989 and from 23% to 41% from 1990 to 1994. The population model in the TEWG projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. It determined that the data reviewed suggested that adult Kemp's ridley turtles were restricted somewhat to the Gulf of Mexico in shallow near shore waters, and benthic immature turtles of 20-60 cm straight line carapace length are found in nearshore coastal waters including estuaries of the Gulf of Mexico and the Atlantic.

The TEWG (1998) identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase. However, the 1996 and 1997 nest numbers reflected a slower rate of growth, while the increase in the 1998 nesting level has been much higher and decreased in 1999. The population growth rate does not appear as steady as originally forecasted by the TEWG, but annual fluctuations, due in part to irregular inter-nesting periods, are normal for other sea turtle populations. Also, as populations increase and expand, nesting activity would be expected to be more variable.

Hurricane Gilbert expanded the area surveyed for ridley nests in Mexico in 1990 due to destruction of the primary nesting beach. The TEWG (1998) assumed that the increased nesting observed particularly since 1990 was a true increase, rather than the result of expanded beach coverage. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather than an expanding ridley nesting range. As noted by TEWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's Ridley Recovery Plan.

Natural History. Juvenile Kemp's ridleys use northeastern and mid-Atlantic coastal waters of the U.S. Atlantic coastline as primary developmental habitat during summer months, with shallow coastal embayments serving as important foraging grounds. Post-pelagic ridleys feed primarily on crabs, consuming a variety of species, including *Callinectes* sp., *Ovalipes* sp., *Libinia* sp., and *Cancer* sp. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal, 1997). Juvenile ridleys migrate south as water temperatures cool in fall, and are predominantly found in shallow coastal embayments along the Gulf Coast during fall and winter months. Ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 40 centimeters in carapace length, and weighing less than 20 kilograms (Klinger and Musick 1995). Next to loggerheads, they are the second most abundant sea turtle in Virginia and Maryland waters, arriving in these areas during May and June, and migrating to more southerly waters from September to November (Keinath *et al.*, 1987; Musick and Limpus, 1997). In the Chesapeake Bay, ridleys frequently forage in shallow embayments, particularly in areas supporting submerged aquatic vegetation (Lutcavage and Musick, 1985; Bellmund *et al.*, 1987; Keinath *et al.*, 1987; Musick and Limpus, 1997). The juvenile population in Chesapeake Bay is estimated to be 211 to 1,083 turtles (Musick and Limpus, 1997).

Research being conducted by Texas A&M University has resulted in the intentional live-capture of hundreds of Kemp's ridleys at Sabine Pass and the entrance to Galveston Bay. Between 1989 and 1993, Galveston NMFS Laboratory staff tracked 50 of these turtles using satellite and radio telemetry. The tracking study was designed to characterize sea turtle habitat and to identify small and large-scale migration patterns. Preliminary analysis of the data collected during these studies suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NMFS Galveston Laboratory, pers. comm.).

Threats. Observations in the northeast otter trawl fishery, pelagic longline fishery, and southeast shrimp and summer flounder bottom trawl fisheries have recorded takes of Kemp's ridley turtles. As with loggerheads, a large number of Kemp's ridleys are taken in the southeast shrimp fishery each year. Kemp's ridleys were also affected by the apparent large-mesh gillnet interaction that occurred in spring off of North Carolina. A total of five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 277 loggerhead carcasses were found. This is expected to be a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction since it is unlikely that all carcasses washed ashore. Stranding events illustrate the vulnerability of Kemp's ridley and loggerhead turtles to the impacts of human activities in nearshore Gulf of Mexico waters as well (TEWG 1998). While many of the stranded turtles observed in recent years in Texas and Louisiana have been incidentally taken in the shrimp fishery, other sources of mortality, such as those observed in the northeastern and southeastern Atlantic zones, exist in these waters.

Critical Habitat. No critical habitat has been designated for the Kemp's ridley turtle.

Smalltooth Sawfish

All modern sawfish belong to the Suborder Pristoidea, Family Pristidae, and Genus *Pristis*. Although they are rays, sawfish appear to be more shark-like than ray-like, with only the trunk and especially the head ventrally flattened. The snout of all sawfish is extended as a long narrow flattened rostral blade with a series of transverse teeth along either edge, hence the vernacular name. Species in the genus *Pristis* are separable into two groups according to whether the caudal fin has a distinct lower lobe or not. The smalltooth sawfish, *Pristis pectinata*, is the sole known representative on the western side of the Atlantic of the group lacking a defined lower caudal lobe (NMFS, 2000).

Distribution. The smalltooth sawfish has a circumtropical distribution and has been reported from shallow coastal and estuarine habitats. In U.S. waters, *P. pectinata* historically occurred from North Carolina south through the Gulf of Mexico, where it was sympatric with the largetooth sawfish (west and south of Port Arthur, TX) (Adams and Wilson, 1995). It also was an occasional visitor to waters as far north as New York. As with all sawfishes, it is euryhaline, occurring in fresh water, nearshore estuaries and in coastal waters to depths of 25 meters.

Pristis pectinata is the largest of the sawfishes, reported to reach 760 cm while more commonly growing to 550 cm (Last and Stevens 1994). Bigelow and Schroeder (1953) reported litter size of 15-20 embryos. Overall, life history parameters for this species are largely unknown.

In the United States, smalltooth sawfish are generally a shallow water fish of inshore bars, mangrove edges, and seagrass beds, but are occasionally found in deeper coastal waters. Records indicate that smalltooth sawfish have been found in the lower reaches of the St. Johns River and the Indian River lagoonal system. Individuals have also historically been reported to migrate northward along the Atlantic seaboard in the warmer months.

Updated collection records from the Florida Museum of Natural History of the University of Florida include 13 records of *P. pectinata* from 1912 to 1998 (with one record not dated). Nine of these specimens were recorded from the Gulf of Mexico off Florida, three came from the Atlantic side of Florida, and one animal was caught in Pacific waters off Ecuador. Three additional records of smalltooth sawfish from the Atlantic coast of Florida have yet to be cataloged in this collection: one specimen is from 1979; the second is not dated (the Museum received both these fish from the Harbor Branch Oceanographic Institute); a third specimen was landed May 22, 1998 from the Indian River (Burgess, pers. comm.). There are eight reports of smalltooth sawfish along the Florida east coast in the 1990's, most from coastal rather than lagoonal areas.

General Human-related impacts. The principal habitats for smalltooth sawfish in the southeast U.S. are the shallow coastal areas and estuaries, with some specimens moving upriver in freshwater (Bigelow and Schroeder, 1953). The continued urbanization of the southeastern coastal states has resulted in substantial loss of coastal habitat through such activities as agricultural and urban development; commercial activities; dredge and fill operations; boating; erosion and diversions of freshwater run-off (SAFMC, 1998). Smalltooth sawfish may be especially vulnerable to coastal habitat degradation due to their affinity to shallow, estuarine systems. With the K-selected life history strategy of smalltooth sawfish, including slow growth, late maturation, and low fecundity, long-term commitments to habitat protection are necessary for the eventual recovery of the species.

A complete review of the factors contributing to the decline of the smalltooth sawfish can be found in the "Status Review of Smalltooth Sawfish (*Pristis pectinata*)", (NMFS, 2000) and will not be repeated in detail here.

Status and Trends. The smalltooth sawfish was added to the list of species as candidates under the ESA in 1991, removed in 1997, and placed back on the list again in 1999. In November 1999, NMFS received a petition from the Center of Marine Conservation requesting that this species be listed as endangered under the ESA. NMFS completed a status review for smalltooth sawfish in December 2000, and published a proposed rule to list this the U.S. population of this species as endangered under the ESA on April 16, 2001. On April 1, 2003, the National Marine Fisheries Service (NOAA Fisheries) announced its final determination to list smalltooth sawfish as an endangered species under the Endangered Species Act (ESA).

According to NMFS (2000) "The U.S. DPS of smalltooth sawfish has experienced a ninety percent curtailment of its range and severe declines in abundance. Agriculture, urban development, commercial activities, channel dredging, boating activities, and the diversion of freshwater run-off have resulted in the destruction and modification of smalltooth habitat throughout the southeastern U.S. Although habitat degradation is not likely the primary reason for the decline of smalltooth sawfish abundance and their contracted distribution, it has likely been a contributing factor. Over 50% of the U.S. human population lives within fifty miles of the ocean or Great Lakes. Migration to the coastlines for home, livelihood or recreation is predicted to increase by the year 2010 (National Ocean Service, 2000). Increases in coastal human populations will likely result in additional losses of marine habitats and increased pollution, further threatening the survival of smalltooth sawfish."

Simpfendorfer (2000) used a demographic approach to estimate intrinsic rate of natural increase and population doubling time. Since there are very limited life history data for smalltooth sawfish, much of the data (e.g. reproductive periodicity, longevity and age-at-maturity) were inferred from the more well-known largetooth sawfish. The litter size of smalltooth sawfish in the literature is given as 15 – 20 and Simpfendorfer used a mean of 17.5. However, the data on which this litter size is based are somewhat dubious. To account for uncertainty in the life-history parameters several different scenarios were tested, covering longevities from 30 to 70 years and ages-at-maturity from 10 to 27 years. The results indicated that the intrinsic rate of population increase ranged from 0.08/year to 0.13/ year, and population-doubling times ranged from 5.4 years to 8.5 years. These models assume the literature value for litter size is correct; doubling times would be longer if litter sizes are more in the range observed for largetooth sawfish (1 to 13, with a mean of 7.3). Simpfendorfer concluded:

> The estimated population doubling times for smalltooth sawfish indicate that the recovery times for this population will be very long. There are no data available on the size of the remaining populations, but anecdotal information indicates that smalltooth sawfish survive today in small fragmented areas where the impact of humans, particularly from net fishing, has been less severe. Fragmenting of the population will increase the time that it takes for recovery since the demographic models used in the study above assume a single inter-breeding population. The genetic effects of recovery from very small population sizes may also impact conservation efforts. It is likely that even if an effective conservation plan can be introduced in the near future, recovery to a level where the risk of extinction is low will take decades, while recovery to pre-European settlement levels would probably take several centuries.

Johnson's Seagrass

Species Description. Johnson's seagrass was listed as threatened under the ESA on September 14, 1998 based on the results of fieldwork and a status review initiated in 1990 and is the first marine plant ever listed. Kenworthy (1993, 1997, 1999) discusses the results of the field studies and summarizes an extensive literature review and associated interviews regarding the status of Johnson's seagrass.

The species has only been found growing along approximately 200 km of coastline in southeastern Florida from Sebastian Inlet, Indian River County to northern Key Biscayne. This narrow range and apparent endemism indicates that Johnson's seagrass has the most limited geographic distribution of any seagrass in the world.

Johnson's seagrass occurs in dynamic and disjunct patches throughout its range. Growth appears to be rapid and leaf pairs have short life spans while horizontally spreading from dense apical meristems (Kenworthy 1997). Kenworthy suggested that horizontal spreading rapid growth pattern and a high biomass turnover could explain the dynamic patches observed in distribution studies. New information reviewed in Kenworthy (1999, 1997) confirms *H. johnsonii's* limited geographic distribution in patchy and vertically disjunct areas between Sebastian Inlet and northern Biscayne Bay. Surveys conducted by NMFS and Florida staff in Biscayne Bay, Florida Bay, the Florida Keys, outer Florida Bay, Puerto Rico, and the Virgin Islands provided no verifiable sightings of Johnson's seagrass outside of the range already reported.

Extent of critical habitat. The northern and southern ranges of Johnson's seagrass are defined as Sebastian Inlet and central Biscayne Bay, respectively. These limits to the species' range have been designated as critical habitat for Johnson's seagrass. Within its range, Johnson's seagrass critical habitat designations have been designated for 10 areas: a portion of the Indian River Lagoon, north of the Sebastian Inlet Channel; a portion of the Indian River Lagoon, south of the Sebastian Inlet Channel; a portion of the Indian River Lagoon near the Fort Pierce Inlet; a portion of the Indian River Lagoon, north of the St. Lucie Inlet; a portion of Hobe Sound; a site on the south side of Jupiter Inlet; a site in central Lake Worth Lagoon; a site in Lake Worth Lagoon, Boynton Beach; a site in Lake Wyman, Boca Raton; and a portion of Biscayne Bay. There is no designated critical habitat within the action area.

Life History

Reproductive strategy

The species is perennial and may spread even during winter months under favorable conditions (Virnstein *et al.* 1997). Sexual reproduction in Johnson's seagrass has not been documented. Female flowers have been found; however, dedicated surveys in the Indian River Lagoon have not discovered male flowers, fertilized ovaries, fruits, or seeds either in the field or under laboratory conditions (Jewett-Smith *et al.* 1997). Searches throughout the range of Johnson's seagrass have produced the same results, suggesting that the species does not reproduce sexually or that the male flowers are difficult to observer or describe, as noted for other *Halophila* species (Kenworthy 1997). Surveys to date indicate that the incidence of female flowers appears to be much higher near the inlets leading to the Atlantic Ocean, suggesting that inlet conditions are qualitatively better for flowering than conditions further inshore (Kenworthy pers. comm. 1998). It is possible that male flowers, if they exist, occur near inlets as well. Maintenance of good water quality around inlets may be essential for promoting flowering in the Johnson's seagrass population.

Niche

The essential features of habitat appear to be adequate water quality, salinity, water clarity and stable sediments free from physical disturbance. Important habitat characteristics include shallow intertidal as well as deeper subtidal zones (2-5 m). Water transparency appears to be critical for Johnson's seagrass, limiting its distribution at depth to areas of suitable optical water quality (Kenworthy 1997). In areas in which long-term poor water and sediment quality have existed until recently, such as Lake Worth Lagoon, *H. johnsonii* appears to occur in relatively higher abundance perhaps due to the previous inability of the larger species to thrive. These studies support unconfirmed previous observations that suspended solids and tannin, which reduce light penetration and water clarity, may be important factors limiting seagrass distribution. Good water clarity is essential for *Halophila johnsonii* growth in deeper waters.

Johnson's seagrass occurs over varied depths, environmental conditions, salinities, and water quality. In tidal channels *H. johnsonii* is found in coarse sand substrates, although it has been found growing on sandy shoals, in soft mud near canals and rivers where salinity many fluctuate widely (Virnstein *et al.* 1997). Virnstein has called Johnson's seagrass a "perennial opportunistic species." Within his study areas in the Indian River Lagoon, *H. johnsonii* was found by itself, with other seagrass species, in the intertidal, and (more commonly) at the deep edge of some transects in water depths of up to 180 cm. *H. johnsonii* was found shallowly rooted on sandy shoals, in soft mud, near the mouths of canals, rivers and in shallow and deep water (Virnstein *et al.* 1997). Additionally, recent studies have documented large patches of Johnson's seagrass on flood deltas just inside Sebastian Inlet, as well as far from the influence of inlets (reported at the workshop discussed in Kenworthy, 1997). These sites encompass a wide variety of salinities, water quality, and substrates.

<u>Competitors:</u>
Halophila johnsonii appears to be outcompeted in ideal seagrass habitats where environmental conditions permit the larger species to thrive (Virnstein *et al.* 1997, Kenworthy 1997).

Population Dynamics
<u>Population stability</u>
A factor leading to the listing of *H. johnsonii* is its rareness within its extremely restricted geographic range. Johnson's seagrass is characterized by small size (it is the smallest of all of the seagrasses found within its range, averaging about 3 cm in height), fragile rhizome structure and associated high turnover rate, and is apparently reliant on vegetative means to reproduce, grow and migrate across the sea bottom. These factors make Johnson's seagrass extremely vulnerable to human or environmental impacts by reducing its capacity to repopulate an area once removed. The species and its habitat are impacted by human-related activities throughout the length its range, including bridge construction and dredging, and the species' threatened status produces new and unique challenges for the management of shallow submerged lands. Vessel traffic resulting in propeller and anchor damage, maintenance dredging, dock and marine construction, water pollution, and land use practices could require special management within critical habitat.

<u>Population (genetic) variability</u>:
The Boca Raton and Boynton Beach sites proposed for critical habitat designation have populations that are distinguished by a higher index of genetic variation than any of the central and northern populations examined to date (Kenworthy, 1999). These two sites represent a genetically semi-isolated group that could be the reservoir of a large part of the overall genetic variation found in the species. Information is still lacking on the geographic extent of this genetic variability.

Status and Distribution. Kenworthy (1997, 1999) summarized the newest information on

Johnson's seagrass biology, distribution, and abundance and confirmed the limited range and rareness of this species within its range. Additionally, the apparent restriction of propagation through vegetative means suggests that colonization between broadly disjunct areas is likely difficult, suggesting that the species is vulnerable to becoming endangered if it is removed from large areas within its range by natural or anthropogenic means. Human impacts to Johnson's seagrass and its habitat include: (1) Vessel traffic and the resulting propeller dredging and anchor mooring; (2) dredging; (3) dock and marina construction and shading from these structures; (4) water pollution; and (5) land use practices including shoreline development, agriculture, and aquaculture.

Activities associated with recreational boat traffic account for the majority of human use associated with the proposed critical habitat areas. The destruction of the benthic community due to boating activities, propeller dredging, anchor mooring, and dock and marina construction was observed at all sites during a study by NMFS from 1990 to 1992. These activities severely disrupt the benthic habitat, breaching root systems, severing rhizomes, and significantly reducing the viability of the seagrass community. Propeller dredging and anchor mooring in shallow areas are a major disturbance to even the most robust seagrasses. This destruction is expected to worsen with the predicted increase in boating activity. Trampling of seagrass beds, a secondary effect of recreational boating, also disturbs seagrass habitat. Populations of Johnson's seagrass inhabiting shallow water and water close to inlets, where vessel traffic is concentrated, will be most affected.

The constant sedimentation patterns in and around inlets require frequent maintenance dredging, which could either directly remove essential seagrass habitat or indirectly affect it by redistributing sediments, burying plants and destabilizing the bottom structure. Altering benthic topography or burying the plants may remove them from the photic zone. Permitted dredging of channels, basins, and other in- and on-water construction projects cause loss of Johnson's seagrass and its habitat through direct removal of the plant, fragmentation of habitat, and shading. Docking facilities that, upon meeting certain provisions, are exempt from state permitting also contribute to loss of Johnson's seagrass through construction impacts and shading. Fixed add-ons to exempt docks (such as finger piers, floating docks, or boat lifts) have recently been documented as an additional source of seagrass loss due to shading (Smith and Mezich, 1999).

Decreased water transparency caused by suspended sediments, water color, and chlorophylls could have significant detrimental effects on the distribution and abundance of the deeper water populations of Johnson's seagrass. A distribution survey in Hobe and Jupiter Sounds indicates that the abundance of this seagrass diminishes in the more turbid interior portion of the lagoon where reduced light limits photosynthesis.

Other areas of concern include seagrass beds located in proximity to rivers and canal mouths where low salinity, highly colored water is discharged. Freshwater discharge into areas adjacent to seagrass beds may provoke physiological stress upon the plants by reducing the salinity levels. Additionally, colored waters released into these areas reduce the amount of sunlight available for photosynthesis by rapidly attenuating shorter wavelengths of Photosynthetically Active Radiation.

Continuing and increasing degradation of water quality due to increased land use and water management threatens the welfare of seagrass communities. Nutrient overenrichment caused by inorganic and organic nitrogen and phosphorous loading via urban and agricultural land run-off stimulates increased algal growth that may smother Johnson's seagrass, shade rooted vegetation, and diminish the oxygen content of the water. Low oxygen conditions have a demonstrated negative impact on seagrasses and associated communities.

A wide range of activities funded, authorized or carried out by Federal agencies may affect the essential habitat requirements of Johnson's seagrass. These include authorization by the COE for beach nourishment, dredging, and related activities including construction of docks and marinas; bridge construction projects funded by the Federal Highway Administration; actions by the U.S. Environmental Protection Agency and the COE to manage freshwater discharges into waterways; regulation of vessel traffic by the U.S. Coast Guard; management of national refuges and protected species by the U.S. Fish and Wildlife Service; management of vessel traffic (and other activities) by the U.S. Navy; authorization of state coastal zone management plans by NOAA's National Ocean Service, and management of commercial fishing and protected species by NMFS.

Rangewide trend:
Lamentably, there is currently insufficient information to clearly determine trends in the Johnson's seagrass population, which was described in 1980 and has only been extensively studied during the 1990s. Generally, seagrasses within the range of Johnson's seagrass have declined in some areas and increased in others. Where multiyear mapping studies have been conducted within the Indian River Lagoon, recent increases in Johnson's seagrass have been noted but may be attributed in part to the recent increase in search effort and increased familiarity with this species (Virnstein *et al.* 1997). The authors conclude that from 1994 through 1997, no strong seasonal distribution or increases or decreases in abundance or range can be discerned.

Humpback Whale (Balaenoptera physalus)

Species description and distribution. Humpback whales typically migrate between tropical/sub-tropical and temperate/polar latitudes. Humpback whales feed on krill and small schooling fish on their summer grounds. The whales occupy tropical areas during winter months when they are breeding and calving, and polar areas during the spring, summer, and fall, when they are feeding, primarily on small schooling fish and krill (Caldwell and Caldwell 1983).

In the Atlantic Ocean, humpback whales feed in the northwestern Atlantic during the summer months and migrate to calving and mating areas in the Caribbean. Six separate feeding areas are utilized in northern waters after their return. This area will not be affected because it is within the biologically important area defined by the 200-m (656-ft) isobath on the North American east coast. Humpback whales also use the mid-Atlantic as a migratory pathway and apparently as a feeding area, at least for juveniles. Since 1989, observations of juvenile humpbacks in that area have been increasing during the winter months, peaking January through March (Swingle *et al.*

1993). Biologists theorize that non-reproductive animals may be establishing a winter-feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. They feed on a number of species of small schooling fishes, particularly sand lance and Atlantic herring, by targeting fish schools and filtering large amounts of water for the associated prey. Humpback whales have also been observed feeding on krill.

Life History. Humpback whale reproductive activities occur primarily in winter. They become sexually mature at age four to six. Annual pregnancy rates have been estimated at about 0.40-0.42 (NMFS unpublished and Nishiwaki 1959). Cows will nurse their calves for up to 12 months. The age distribution of the humpback whale population is unknown, but the portion of calves in various populations has been estimated at about 4B12% (Chittleborough 1965, Whitehead 1982, Bauer 1986, Herman *et al.* 1980, and Clapham and Mayo 1987).

The information available does not identify natural causes of death among humpback whales or their number and frequency over time, but potential causes of natural mortality are believed to include parasites, disease, predation (killer whales, false killer whales, and sharks), biotoxins, and entrapment in ice.

Humpback whales exhibit a wide range of foraging behaviors, and feed on a range of prey types including small schooling fishes, euphausiids, and other large zooplankton. Fish prey in the North Pacific include herring, anchovy, capelin, pollack, Atka mackerel, eulachon, sand lance, pollack, Pacific cod, saffron cod, arctic cod, juvenile salmon, and rockfish. In the waters west of the Attu Islands and south of Amchitka Island, Atka mackerel were preferred prey of humpback whales (Nemoto 1957). Invertebrate prey includes euphausiids, mysids, amphipods, shrimps, and copepods.

Diving and social behavior. In Hawaiian waters, humpback whales remain almost exclusively within the 1820 m isobath and usually within 182 m. Maximum diving depths are approximately 150 m (492 ft) (but usually <60 m [197 ft]), with a very deep dive (240 m [787 ft]) recorded off Bermuda (Hamilton *et al.* 1997). They may remain submerged for up to 21 min (Dolphin 1987). Dives on feeding grounds ranged from 2.1-5.1 min in the north Atlantic (Goodyear unpubl. manus.). In southeast Alaska average dive times were 2.8 min for feeding whales, 3.0min for non-feeding whales, and 4.3 min for resting whales (Dolphin 1987). In the Gulf of California humpback whale dive times averaged 3.5 min (Strong 1989). Because most humpback prey is likely found above 300 m depths most humpback dives are probably relatively shallow.

Clapham (1986) reviewed the social behavior of humpback whales. They form small stable groups during the breeding season. During the feeding season they form small groups that occasionally aggregate on concentrations of food. Feeding groups are sometimes stable for long periods of times. There is good evidence of some territoriality on feeding grounds (Clapham 1994, 1996), and on wintering ground (Tyack 1981). On the breeding grounds males sing long complex songs directed towards females, other males or both. The breeding season can best be described as a floating lek or male dominance polygyny (Clapham 1996). Intermale competition for proximity to females can be intense as expected by the sex ratio on the breeding grounds that may be as high as 2.4:1.

Vocalizations and hearing. Humpbacks produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 25-5000 Hz range and intensities as high as 181 dB (Payne 1970; Winn *et al.* 1970a; Thompson *et al.* 1986). Source levels average 155 dB and range from 144 to 174 dB (Thompson *et al.* 1979). The songs appear to have an effective range of approximately six to 12 miles (10 to 20 km). Animals in mating groups produce a variety of sounds (Tyack 1981; Tyack and Whitehead 1983, Silber 1986). Sounds are produced less frequently on the summer feeding grounds. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2-0.8 sec and source levels of 175-192 dB (Thompson *et al.* 1986). These sounds are attractive and appear to rally animals to the feeding activity (D=Vincent *et al.* 1985; Sharpe and Dill 1997). In summary, humpback whales produce at least three kinds of sounds: 1) complex songs with components ranging from at least 20Hz B 4 kHz with estimated source levels from 144 B 174 dB, which are mostly sung by males on the breeding grounds (Payne 1970; Winn *et al.* 1970a; Richardson *et al.* 1995); 2) social sounds in the breeding areas that extend from 50Hz B more than 10 kHz with most energy below 3kHz (Tyack and Whitehead 1983, Richardson *et al.* 1995); and 3) Feeding area vocalizations that are less frequent, but tend to be 20Hz B 2 kHz with estimated sources levels in excess of 175 dB re 1 μPa-m (Thompson *et al.* 1986; Richardson *et al.* 1995). Sounds often associated with possible aggressive behavior by males (Tyack 1983; Silber 1986) are quite different from songs, extending from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz. These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead 1983). A general description of the anatomy of the ear for cetaceans is provided in the description of the blue whale above. Humpback whales respond to low frequency sound. Humpback whales have been known to react to low frequency industrial noises at estimated received levels of 115 B 124 dB (Malme *et al.* 1985), and to conspecific calls at received levels as low as 102dB (Frankel *et al.* 1995). Humpback whales apparently reacted to 3.1 B 3.6 kHz sonar by changing behavior (Maybaum 1990 1993). Malme *et al.* (1985) found no clear response to playbacks of drill ship and oil production platform noises at received levels up to 116dB re 1 μPa. Studies of reactions to airgun noises were inconclusive (Malme *et al.* 1985). Humpback whales on the breeding grounds did not stop singing in response to underwater explosions (Payne and McVay 1971). Humpback whales on feeding grounds did not alter short-term behavior or distribution in response to explosions with received levels of about 150dB re 1 μPa/Hz at 350Hz (Lien *et al.* 1993; Todd *et al.* 1996). However, at least two individuals were likely killed by the high intensity, impulsed blasts and had extensive mechanical injuries in their ears (Ketten *et al.* 1993; Todd *et al.* 1996). The explosions may also have increased the number of humpback whales entangled in fishing nets (Todd *et al.* 1996). Frankel and Clark (1998) showed that breeding humpbacks showed only a slight statistical reaction to playback of 60 B 90 Hz bounds with a received level of up to 190 dB. While these studies have shown short-term behavioral reactions to boat traffic and playbacks of industrial noise, the potential for habituation, and thus the long term effects of these disturbances are not known.

Status and Trends. Humpback whales were listed as endangered under the ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for the species.

New information has become available on the status and trends of the humpback whale population in the North Atlantic (NMFS, 2001). Although current and maximum net productivity rates are unknown at this time, the population is apparently increasing. It has not yet been determined whether this increase is uniform across all six feeding stocks (Waring *et al. in prep.*). Katona and Beard (1990) estimated the rate of increase at 9.0 percent, while Barlow and Clapham (1997) reported a 6.5 percent rate for the Gulf of Maine using data through 1991. The rate reported by Barlow and Clapham (1997) may roughly approximate the rate of increase for the portion of the population within the action area. The best estimate of abundance for the North Atlantic humpback whale population is 10,600 animals (CV=0.067; Smith *et al.* 1999), while the minimum population estimate used for NMFS management purposes is 10,019 animals (CV = 0.067; Waring *et al. in prep.*). The Northeast Fisheries Science Center is considering recommending that NMFS identify the Gulf of Maine feeding stock as the management stock for this population in U.S. waters. A population estimate for the Gulf of Maine portion of the population is not available.

Threats. In the 1990s, no more than 3 humpback whales were killed annually in U.S. waters by commercial fishing operations in the Atlantic and Pacific Oceans. Between 1990 and 1997, no humpback whale deaths have been attributed to interactions with groundfish trawl, longline and pot fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska (Hill and DeMaster 1999). Humpback whales have been injured or killed elsewhere along the mainland U.S. and Hawaii (Barlow *et al.* 1997). In 1991, a humpback whale was observed entangled in longline gear and released alive (Hill *et al.* 1997). In 1995, a humpback whale in Maui waters was found trailing numerous lines (not fishery-related) and entangled in mooring lines. The whale was successfully released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone.

Humpback whales seem to respond to moving sound sources, such as whale-watching vessels, fishing vessels, recreational vessels, and low-flying aircraft (Beach and Weinrich 1989, Clapham *et al.* 1993, Atkins and Swartz 1989). Their responses to noise are variable and have been correlated with the size, composition, and behavior of the whales when the noises occurred (Herman *et al.* 1980, Watkins *et al.* 1981, Krieger and Wing 1986). Several investigators have suggested that noise may have caused humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979b, Dean *et al.* 1985), while others have suggested that humpback whales may become habituated to vessel traffic and its associated noise. Still other researchers suggest that humpback whales may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle *et al.* 1993; Wiley *et al.* 1995).

Many humpback whales are killed by ship strikes along both coasts of the U.S. On the Atlantic coast, 6 out of 20 humpback whales stranded along the mid-Atlantic coast showed signs of major ship strike injuries (Wiley *et al.* 1995). Almost no information is available on the number of humpback whales killed or seriously injured by ship strikes outside of U.S. waters.

Sperm Whale (Physeter macrocephalus)

Species description and distribution. Sperm whales are distributed in the entire world's oceans. Sperm whales have a strong preference for the 3,280 ft (1,000 m) depth contour and seaward. Berzin (1971) reported that they are restricted to waters deeper than 300 m (984 ft), while Watkins (1977) and Reeves and Whitehead (1997) reported that they are usually not found in waters less than 3,281 ft (1,000m) deep. While deep water is their typical habitat, sperm whales have been observed near Long Island, NY, in waters of 41-55 m (135-180 ft) (Scott and Sadove

1997). When found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956). They can dive to depths of at least 2000 m (6562 ft), and may remain submerged for an hour or more (Watkins *et al.* 1993). Sperm whales feed primarily on buoyant, relatively slow-moving squid (Clark *et al.* 1993), but may also eat a variety of fish, including salmon (*Oncorhynchus* spp.), rockfish (*Sebastes* spp.), and lingcod (*Ophiodon elongatus*) (Caldwell and Caldwell 1983).

In the Atlantic Ocean, NMFS' most recent stock assessment report notes that sperm whales are distributed in a distinct seasonal cycle, concentrated east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the Mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight. There is also a very large population of sperm whales found in the Gulf of Mexico near the Mississippi River delta.

Life History. Female sperm whales take about 9 years to become sexually mature (Kasuya 1991, as cited in Perry *et al.* 1999). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). Adult females give birth after about 15 months gestation and nurse their calves for 2 - 3 years. The calving interval is estimated to be about four to six years (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980, as cited in Perry *et al.* 1999). Sperm whales are known for their deep foraging dives (in excess of 3 km). They feed primarily on mesopelagic squid, but also consume octopus, other invertebrates, and fish (Tomilin 1967, Tarasevich1968, Berzin 1971). Perez (1990) estimated that their diet in the Bering Sea was 82% cephalopods (mostly squid) and 18% fish. Fish eaten in the North Pacific included salmon, lantern fishes, lancetfish, Pacific cod, pollack, saffron cod, rockfishes, sablefish, Atka mackerel, sculpins, lumpsuckers, lamprey, skates, and rattails (Tomilin 1967, Kawakami 1980, Rice 1986b). Sperm whales taken in the Gulf of Alaska in the 1960s had fed primarily on fish. Daily food consumption rates for sperm whales ranges from 2 - 4% of their total body weight (Lockyer 1976b, Kawakami 1980). Potential sources of natural mortality in sperm whales include killer whales and papilloma virus (Lambertson *et al.* 1987).

Diving and social behavior. Sperm whales are likely the deepest and longest diving mammals. Typical foraging dives last 40 min and descend to about 400m followed by approximately 8 min of resting at the surface (Gordon 1987; Papastavrou et al. 1989). However, dives of over 2 hr and as deep as 3,000 m have been recorded (Clarke 1976; Watkins et al. 1985). Descent rates recorded from echosounders were approximately 1.7m/sec and nearly vertical (Goold and Jones 1995). There are no data on diurnal differences in dive depths in sperm whales. However, like most diving vertebrates for which there is data (e.g. rorqual whales, fur seals, chinstrap penguins), sperm whales probably make relatively shallow dives at night when organisms from the ocean's deep scattering layers move toward the ocean's surface.

The groups of closely related females and their offspring develop dialects specific to the group (Weilgart and Whitehead 1997) and females other than birth mothers will guard young at the surface (Whitehead 1996b) and will nurse young calves (Reeves and Whitehead 1997).

Vocalizations and hearing. Sperm whales produce loud broadband clicks from about 0.1 to 20 kHz (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). These have source levels estimated at 171 dB re 1 μPa (Levenson 1974). Current evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce these vocalizations (Norris and Harvey 1972; Cranford 1992; but see Clarke 1979). This suggests that the production of these loud low frequency clicks is extremely important to the survival of individual sperm whales. The function of these vocalizations is relatively well studied (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). Long series of monotonous regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Distinctive, short, patterned series of clicks, called codas, are associated with social behavior and intragroup interactions; they are thought to facilitate intra-specific communication, perhaps to maintain social cohesion with the group (Weilgart and Whitehead 1993).

A general description of the anatomy of the ear for cetaceans is provided in the description of the blue whale above. The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1990). These data suggest that neonatal sperm whales respond to sounds from 2.5-60 kHz. Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Schevill 1975; Watkins *et al.* 1985). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Sperm whales have moved out of areas after the start of air gun seismic testing (Davis *et al.* 1995). Seismic air guns produce loud, broadband, impulsive noise (source levels are on the order of 250 dB) with shots at every 15 seconds, 240 shots per hour, and 24 hours per day during active tests. Because they spend large amounts of time at depth and use low frequency sound sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll *et al* 1999). Furthermore, because of their apparent role as important predators of mesopelagic squid and fish, changes in their abundance could affect the distribution and abundance of other marine species.

Status and Trends. Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). Sperm whales were listed as endangered under the ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for sperm whales.

The best abundance estimate that is currently available for the western North Atlantic sperm whale population is 2,698 (CV=0.67) animals, and the minimum population estimate used for NMFS management purposes is 1,617 (CV=0.67) (Waring *et al. in prep.*). Due to insufficient data, no information is available on population trends at this time for the western North Atlantic sperm whale stock.

Threats. In U.S. waters in the Pacific, sperm whales are known to have been incidentally taken only in drift gillnet operations, which killed or seriously injured an average of 9 sperm whales per year from 1991-1995 (Barlow *et al.* 1997). Interactions between longline fisheries and sperm whales in the Gulf of Alaska have been reported over the past decade (Rice 1989, Hill and DeMaster 1999). Observers aboard Alaskan sablefish and halibut longline vessels have documented sperm whales feeding on fish caught in longlines in the Gulf of Alaska. During 1997, the first entanglement of a sperm whale in Alaska's longline fishery was recorded, although the animal was not seriously injured (Hill and DeMaster 1998). The available evidence does not indicate sperm whales are being killed or seriously injured as a result of these interactions, although the nature and extent of interactions between sperm whales and long-line gear is not yet clear.

Protected Species Surveys within the project area.

Surveys specifically targeting protected species were not conducted in the action area, however an Environmental Baseline Study and Impact Assessment were prepared. This assessment, literature reviews and consultations with NMFS serve as the basis for this biological assessment and the determination of which listed and protected species under NMFS' jurisdiction are found in the project area.

Sea Turtles

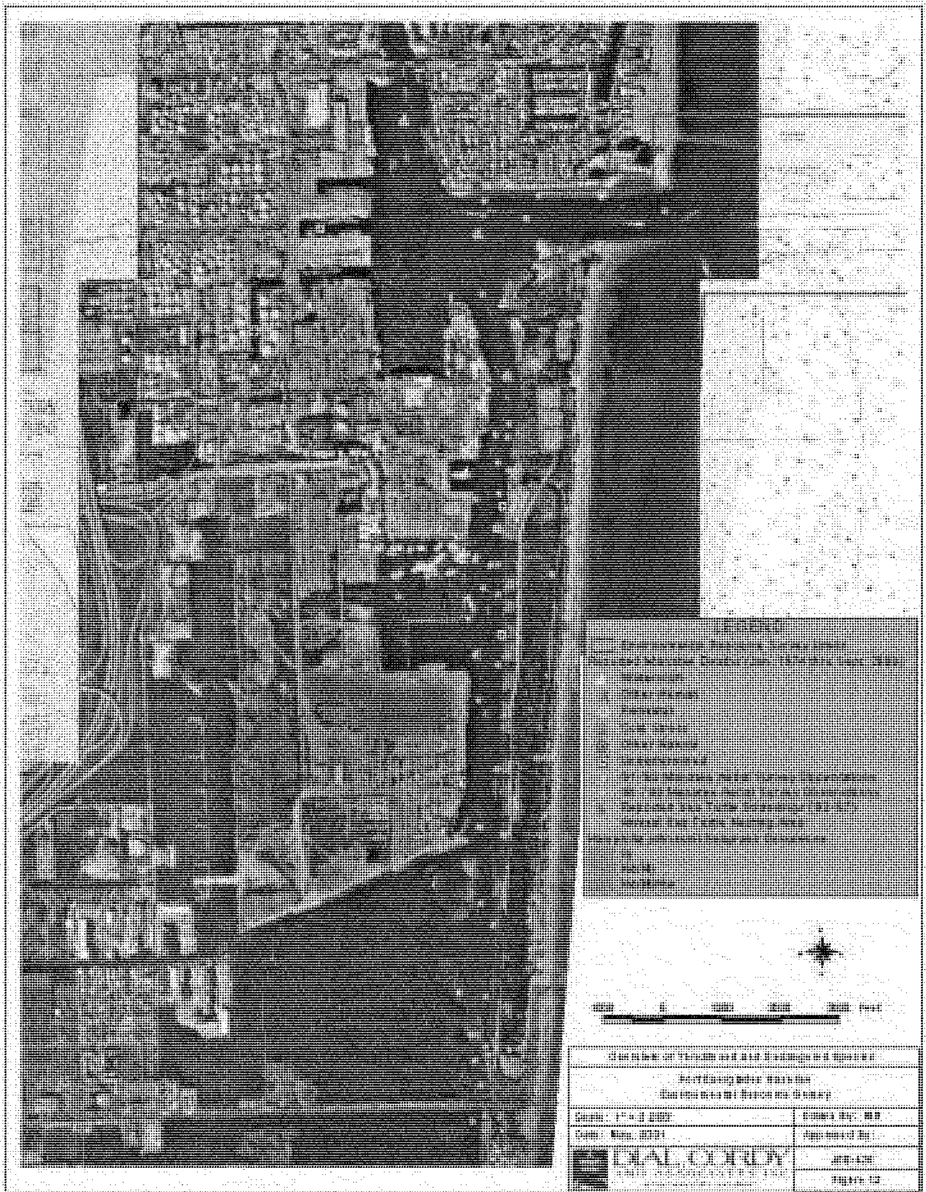
Broward County is within the normal nesting range of three species of sea turtles: the loggerhead (*Caretta caretta*), the green turtle (*Chelonia mydas*), and the leatherback (*Dermochelys coriacea*). The green sea turtle and leatherback sea turtle are both listed under the U. S. Endangered Species Act, 1973 and Chapter 370, F.S. The loggerhead turtle is listed as a threatened species (Burney and Margolis, 1999). A summary of sea turtle nesting in Broward County can be found in Tables 1, 2 and 3 in the species description section of this assessment. The majority of sea turtle nesting activity occurred during the summer months of June, July and August, with nesting activity occurring as early as March and as late as September (Burney and Margolis, 1999). The waters offshore of Broward County are also habitat used for foraging and shelter for the three species listed above and possibly the hawksbill turtle (*Eretmochelys imbricata*), and the Kemp's ridley turtle (*Lepidochelys kempii*) (USACE, 2000) (Figure 3).

Six (6) stranded threatened and endangered sea turtles have been reported within the Port boundaries: 3 loggerheads, 2 green turtles and 1 hawksbill. In addition there were 13 incidental capture records - 1 green turtle was caught on hook and line and 12 turtles (6 loggerheads, 2 green turtles, 2 hawksbills and 2 unidentified species) were caught in the power plant at Port Everglades (Wendy Teas, pers. Comm. 2002).

Johnson's Seagrass

Johnson's seagrass occurs within the project area, specifically in the Intracoastal Waterway east and south of the Main Turning Basin, and just west of the Dania Cutoff Canal, and in the Dania Cutoff Canal. Abundance and density values are low and the species is generally associated with *H. decipiens.* Johnson's seagrass also occurs south of the Dania Cutoff Canal within Whiskey Creek, along the western shore of the Intracoastal Waterway and within the West Lake Park embayment (Miller Legg, 2001). Cover-abundance and density were higher along the west shore of West Lake Park than was observed within the Port Everglades project area. No designated critical habitat is

Fig 3 – Endangered & Threatened Species Locations



found within the project boundaries or within the vicinity of the project site (Figure 4 & 5).

Smalltooth sawfish

This species inhabits softbottom estuarine habitats in depths generally less than 30 feet. Its former range in U.S. waters extended from Texas through Maryland. Currently, few are observed outside peninsular Florida. At least one recorded observation has occurred within the vicinity of Broward County (NMFS, 2000). Populations likely decreased due to a low intrinsic rate of natural increase, the long interval to time of reproduction, and human impacts, most notably overfishing, incidental take in nets (due in part to its body size and unusual morphology), and habitat loss (development of shoreline and nearshore habitats).

Humpback and Sperm Whales

These species are found offshore of the project area in deepwater beyond the third reef line. Sperm whales may be found year round near the project area, while humpbacks are found seasonally during their migration to and from breeding grounds in the Caribbean.

Other consultations of Federal actions in the area to date

The Corps has been working with the citizens of Broward County for several years on expanding and maintaining Port Everglades (Table 4). None of the projects authorized by Congress through 1968 were required to consult under the Endangered Species Act of 1973 (ESA). Port Everglades projects following implementation of the ESA include the 1974 deepening and widening of the entrance channel on a new alignment, as well as deepening the turning basin and add the channel now referred to as the Southport Access Channel.

The Corps is also working with Broward County on the Broward County Shore protection project, located outside of the port boundaries to the north and the south. Construction on the shore protection project is scheduled to begin in the fall of 2004. The Corps believes that the sea turtle species addressed in the current biological assessment may be affected, but not adversely affected in any way by the project. The NMFS Informal Section 7 consultation on that project (March 10, 2000) concurred with the finding of may affect, not likely to adversely affect listed species or adversely effect designated critical habitat under NMFS jurisdiction in the project area (consultation number 1514-22f.1.).

Table 4: Previously Authorized Federal Actions at Port Everglades Harbor

ACTS	WORK AUTHORIZED	DOCUMENTS
3 Jul 1930	Maintenance of harbor constructed by local interests.	H. Doc. 357/71/2
30 Aug 1935	Enlarge entrance channel to existing project dimensions and complete turning basin to 1,200 feet square.	R. & H. Comm. Doc. 25/74/1
20 Jun 1938	Widen turning basin 350 feet on north side.	H. Doc. 545/75/3
24 Jul 1946	Widen turning basin 200 feet on north side, 500 feet	H. Doc. 768/78/2

Fig 4 – Seagrass Locations in Northern portion

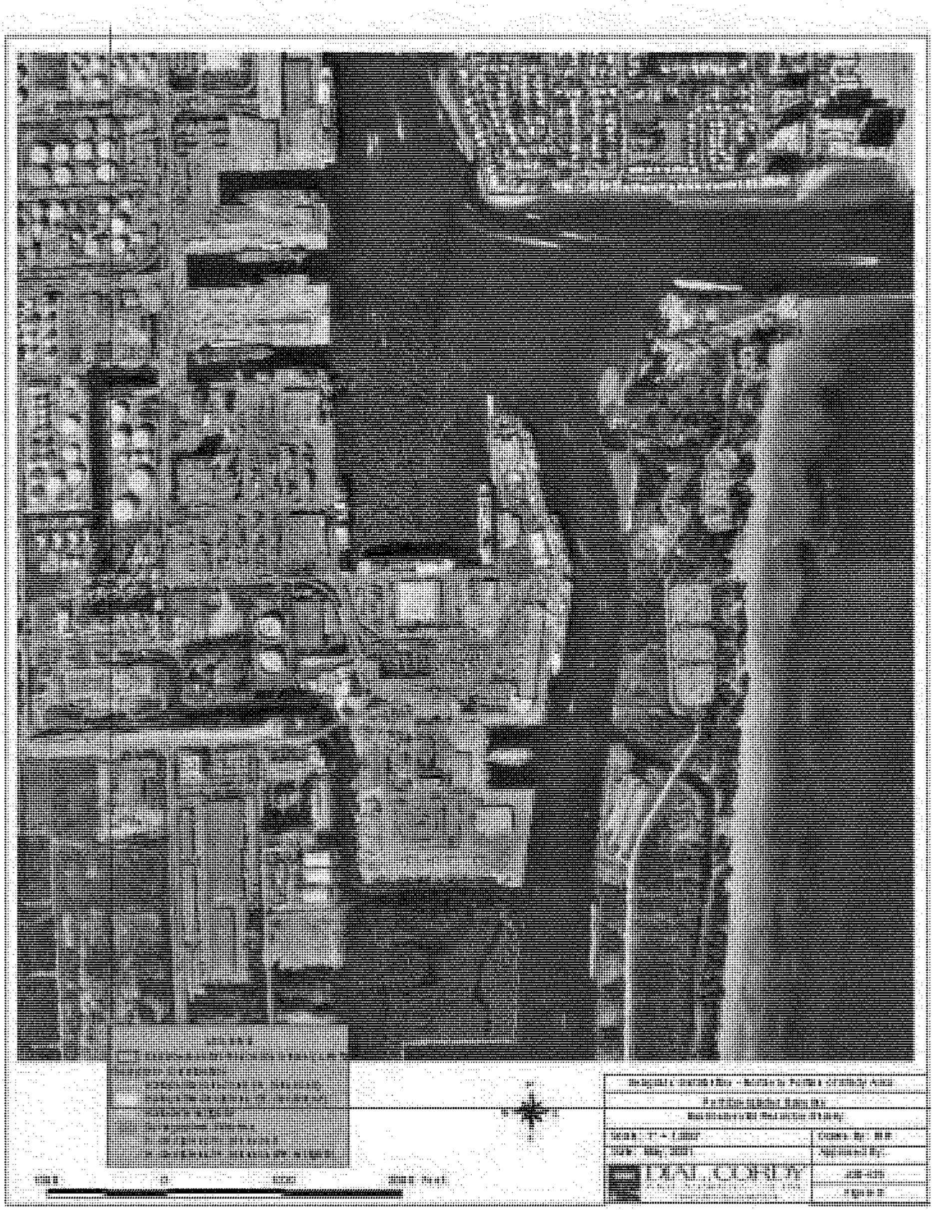
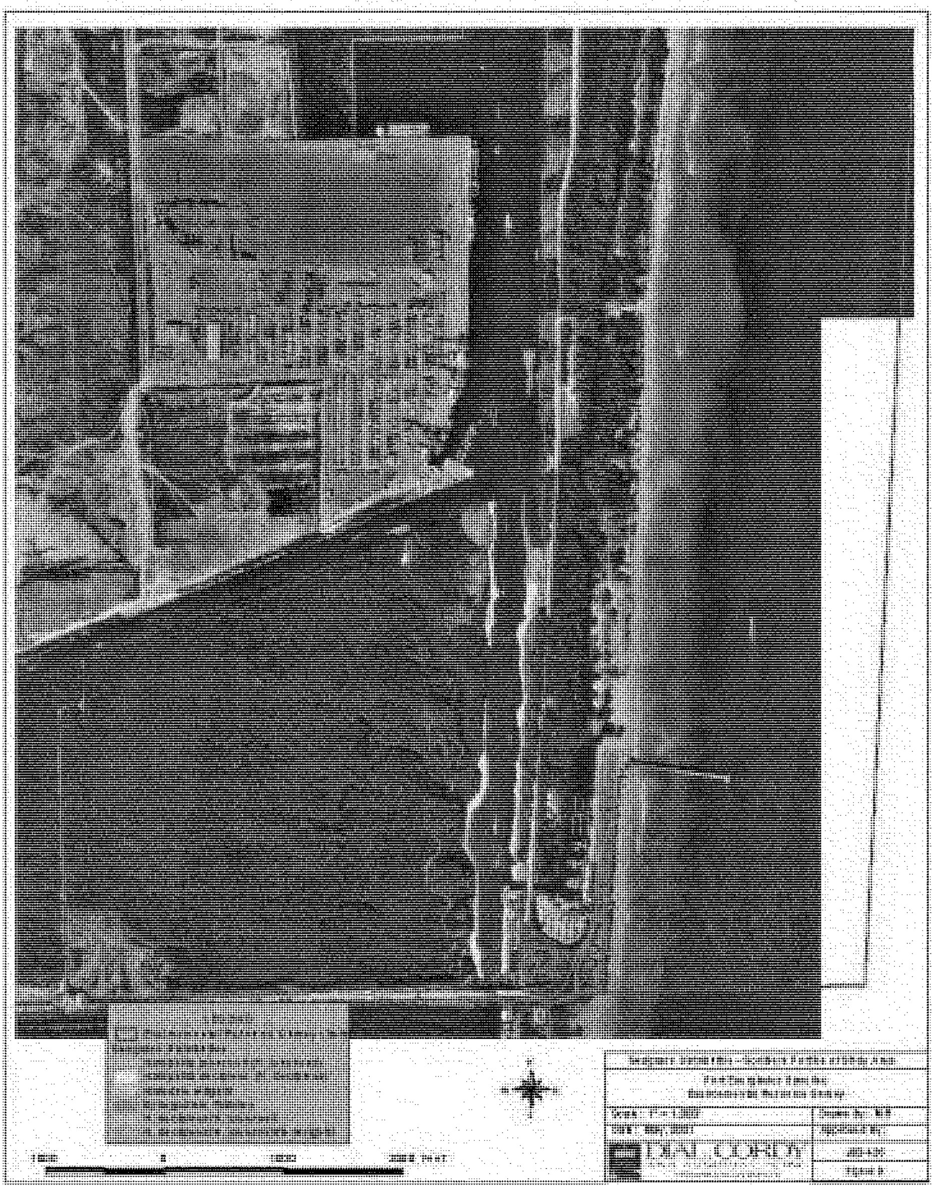


Fig 5 – Seagrass Locations in Southern portion



	on south side, and enlarge flare at entrance channel.	
3 Jul 1958	Deepen and widen entrance channel on a new alignment and increase turning basin in size and depth.	H. Doc. 346/85/2
H.R. 9 May 1974 S.R.31 May 1974	Deepen and widen entrance channel on a new alignment, deepen turning basin and add a new channel to the southeast of the turning basin.	H. Doc. 144/93/1

Projects completed by the Port without Federal assistance

1987	Port Everglades. Final Environmental Impact Statement, Proposed Expansion Port Everglades, Broward County, Florida. EIS for deepening and widening the Southport Access Channel, bulkheading port land, creation of the Turning Notch.

Protective Measures Taken in the Project Area as Part of the Proposed Action
Consideration of Plans and Methods to Minimize/Avoid Environmental Impacts. Conservation measures were a major focus during the plan formulation phase for the proposed project. Avoiding and minimizing some potential impact areas significantly decreased the risk of indirect effects on managed and protected species, and a great deal of consideration was given to the utilization of rock removal methods to decrease the likelihood of incidental take, injury, and behavioral modification of protected species. While efforts to reduce impacts to habitats were fruitful, it was determined that rock removal options not involving blasting were possibly more detrimental to populations and individuals of protected species. One alternative option was the use of a punchbarge/piledriver to break rock. However, it was determined that the punchbarge, which would work for 12-hour periods, strikes the rock approximately once every 60-seconds. This constant pounding would serve to disrupt animal behavior in the area. Using the punchbarge would also extend the length of the project, thus increasing any potential impacts to all fish and wildlife resources in the area. The Corps believes that blasting is actually the least environmentally damaging method for removing the rock in the Port. Each blast will last no longer than five (5) seconds in duration, and may even be as short as 2 seconds each. Additionally, the blasts are confined in the rock substrate. Boreholes are drilled into the rock below, the blasting charge is set, and then the chain of explosives is detonated. Because the blasts are confined within the rock structure, the distance of the blast effects are reduced as compared to an unconfined blast (see discussion below).

Development of Protective Measures. The proposed project includes measures to conserve sperm and humpback whale, sea turtles and smalltooth sawfish. Foremost among the measures are protective actions to ensure that sea turtles and smalltooth sawfish are not killed and whales are not harassed due to blasting activities, if in fact such methods are required as a part of the overall dredging operation. Development of the measures involved consideration of past practices and operations, anecdotal observations, and the most current scientific data. The discussion below summarizes the development of the conservation measures, which, although developed for marine mammals, will also be utilized to protect such species as sea turtles and smalltooth sawfish.

Blasting
To achieve the deepening of the Port Everglades pretreatment of the rock areas may be required. Blasting is anticipated to be required for some or all of the deepening and extension of the channel, where standard construction methods are unsuccessful. The work may be completed in the following manner:

1. Contour dredging with either bucket, hydraulic or excavator dredges to remove material that can be dredged conventionally and determine what areas require blasting.

2. Pre-treating (blasting) the remaining above grade rock, drilling and blasting the "Site Specific" areas where rock could not be conventionally removed by the dredges.

3. Excavating with bucket, hydraulic or excavator dredges to remove the pre-treated rock areas to grade.

All drilling and blasting will be conducted in strict accordance with local, state and federal safety procedures. Marine Wildlife Protection, Protection of Existing Structures, and Blasting Programs coordinated with federal and state agencies.

Based upon industry standards and USACE, Safety & Health Regulations, the blasting program may consist of the following:

The weight of explosives to be used in each blast will be limited to the lowest poundage of explosives that can adequately break the rock. The blasting would consist of up to 3 blasts per day, preparing for removal of approximately 1500 cubic yards per blast.

The following safety conditions are standard in conducting underwater blasting:

- Drill patterns are restricted to a minimum of 8 ft separation from a loaded hole.
- Hours of blasting are restricted from 2 hours after sunrise to 1 hour before sunset to allow for adequate observation of the project area for protected species.
- Selection of explosive products and their practical application method must address vibration and air blast (overpressure) control for protection of existing structures and marine wildlife.
- Loaded blast holes will be individually delayed to reduce the maximum pounds per delay at point detonation, which in turn will reduce the mortality radius.
- The blast design will consider matching the energy in the "work effort" of the borehole to the rock mass or target for minimizing excess energy vented into the water column or hydraulic shock.

Because of the potential duration of the blasting and the project area as habitat for listed and threatened species, a number of issues will need to be addressed. One of the key issues is the extent of a safety radius for the protection of marine wildlife. This is the distance from the blast site which any protected species must be in order to commence blasting operations. Ideally the safety radius is large enough to offer a wide buffer of protection for marine animals while still remaining small enough that the area can be intensely surveyed

There are a number of methods that can be used to calculate a safety radius. Little published data exists for actual measurements of sub aqueous blasts confined to a rock layer and their impacts to marine mammals or turtles. There is some information on the impacts to fish from similar blasts. Both literature searches and actual observations from similar blasting events will be used as a guide in establishing a safety radius that affords the best protection from lethal harm to marine wildlife. The following will be considered in establishing the radius for blasting inshore of the outer reef:

The U.S. Navy Dive Manual and the FFWCC Endangered Species Watch Manual the safety formula for an uncontrolled blast suspended in the water column, which is as follows:

R = 260 (cube root w)
R = Safety radius

W = Weight of explosives

This formula is a conservative for the blasting being done within Port Everglades, as the blast will be confined within the rock and not suspended in the water column. This formula and plan are consistent with the plans for Miami Harbor Phase II and Miami Harbor GRR that the Corps consulted with NMFS on (I/SER/2002/00178 – September 23, 2002 and F/SER/2002/01094 – February 23, 2003, respectively). In both cases, NMFS found concurred with the Corps' determination that the proposed confined blasting at Miami Harbor "may affect, but is not likely to adversely affect sea turtles". The Port Everglades blasting plan has been designed to be consistent with the Miami Harbor projects. Should new information come from the Miami harbor projected (Phase II is scheduled to begin construction in Fall 2004) that would result in changes (as lessons learned) they will be incorporated into the plans for Port Everglades in consultation with all the resource agencies.

If blasting is required on the outer reef, the Corps proposes to use aerial and passive acoustic surveys to determine if there are sperm or humpback whales within a 1-nautical mile (nm) radius of the project area. In the Biological Opinion for the shock trial of the USS Winston Churchill (DDG-81) (NMFS, 2000b), NMFS required the Navy to establish a zone of 3 nm for acoustic monitoring and 2 nm for aerial monitoring for three 10,000 lb open water unconfined explosions. Blasting for the channel extension will utilize confined blasts drilled into the substrate, and as a result the Corps believes that any acoustic or pressure effects to the project area will be substantially less than those evaluated by NMFS in setting the safety zones for the Churchill tests.

Conservation Measures
It is crucial to balance the demands of the blasting operations with the overall safety of the species. A radius that is excessively large will result in significant delays that prolong the blasting, construction, traffic and overall disturbance to the area. A radius that is too small puts the animals at too great of a risk should one go undetected by the observers and move into the blast area. Because of these factors, the goal is to establish the smallest radius possible without compromising animal safety and provide adequate observer coverage for whatever radius is agreed upon.

Aerial reconnaissance, where feasible and possible, is critical to support the safety radius selected in addition to boat-based and land support reconnaissance. Additionally, an observer will be placed on the drill barge for the best view of the actual blast zone and to be in direct contact with the blaster in charge.

Prior to implementing a blasting program a Test Blast Program will be completed. The purpose of the Test Blast Program is to demonstrate and/or confirm the following:

- Drill Boat Capabilities and Production Rates
- Ideal Drill Pattern for Typical Boreholes
- Acceptable Rock Breakage for Excavation
- Tolerable Vibration Level Emitted

- Directional Vibration
- Calibration of the Environment

The Test Blast Program begins with a single range of individually delayed holes and progresses up to the maximum production blast intended for use. Each Test Blast is designed to establish limits of vibration and airblast overpressure, with acceptable rock breakage for excavation. The final test event simulates the maximum explosive detonation as to size, overlying water depth, charge configuration, charge separation, initiation methods, and loading conditions anticipated for the typical production blast.

The results of the Test Blast Program will be formatted in a regression analysis with other pertinent information and conclusions reached. This will be the basis for developing a completely engineered procedure for Blasting Plan. During the testing the following data will be used to develop a regression analysis:

- Distance
- Pounds Per Delay
- Peak Particle Velocities (TVL)
- Frequencies (TVL)
- Peak Vector Sum
- Air Blast, Overpressure

Other Rock Removal Options

The Corps investigated methods to remove the rock in Port Everglades without blasting using a punchbarge. It was determined that the punchbarge, which would work for 12-hour periods, strikes the rock below approximately once every 60-seconds. This constant pounding would serve to disrupt manatee behavior in the area, as well as impact other marine animals in the area. Using the punchbarge will also extend the length of the project temporally, thus increasing any potential impacts to all fish and wildlife resources in the area. A punchbarge has been tried in the past at Port Everglades without success due to rock hardness.

The Corps believes that blasting is actually the least environmentally damaging method for removing the rock in the Port. Each blast will last no longer than 5-seconds in duration, and may even be as short as 2 seconds, occurring no more than three times per day. As stated previously, the blasts are confined in the rock substrate. Boreholes are drilled into the rock below, the blasting charge is set and then the chain of explosives is detonated. Because the blasts are confined within the rock structure, the distance of the blast effects are reduced as compared to an unconfined blast.

Effects of the Action on Protected Species.

As previously stated, the Corps believes that the loggerhead turtle, green turtle, smalltooth sawfish and Johnson's seagrass have the potential to be effected by the proposed dredging project. The project may have the following adverse impacts on listed/protected species are:

- direct effect of blasting in the turning basin.

- direct effect of dredging activities
- indirect effects

Direct Effects
Blasting

Sea turtles
Specific information regarding the likely direct impact of explosives on sea turtles is not available. Studies regarding the impacts of relatively minuscule explosives on humans noted that minor injuries such as small bruises or perforations of the intestinal tract occasionally occur well beyond ranges in which human lung damage could occur (Christian and Gaspin, 1974). Christian and Gaspin (1974) note that these minor injuries could become serious if left unattended. Sea turtles with untreated internal injuries would have increased vulnerability to predators and disease. In the Environmental Impact Statement prepared by the Navy to consider the effects of explosives used in shipshock tests, nervous system damage was cited as a possible impact to sea turtles caused by blasting. Damage of the nervous system could kill sea turtles through disorientation and subsequent drowning. The Navy's review of previous studies suggested that rigid masses such as bone (or carapace and plastron) could protect tissues beneath them; however, there are no observations available to determine whether the turtles' shells would indeed afford such protection.

Studies conducted by Klima *et al.*, (1988) evaluated blasts of only approximately 42 lbs on sea turtles (4 ridleys, 4 loggerheads) placed in surface cages at varying distances from the explosion. Christian and Gaspin's (1974) estimates of safety zones for swimmers found that, beyond a cavitation area, waves reflected off a surface have reduced pressure pulses; therefore, an animal at shallow depths would be exposed to a reduced impulse. This finding, which considered only very small explosive weights, implies that the turtles in the Klima *et al.* (1988) study would be under reduced effects of the shock wave. Despite this possible lowered level of impact, 5 of 8 turtles were rendered unconscious at distances of 229 to 915 m from the detonation site. Unconscious sea turtles that are not detected, removed and rehabilitated likely have low survival rates.

Blasting will affect nearby finfish and invertebrates and cause short-term changes to the physical characteristics of the benthos. Fish and invertebrates killed or injured by the blasting may provide a short-term enhancement of foraging opportunities for green and loggerhead sea turtles. Through new recruitment and local migrations, finfish and benthic invertebrates are expected eventually to repopulate the affected area. Any modifications of the local area's environment, as far as sea turtle habitat, are not expected to be significant in the long term.

Smalltooth Sawfish
Blasting rock underwater produces a pressure wave in water that can produce fish mortality. Different types of fish have different mortality thresholds. This depends on whether the fish dwell near the surface, on the bottom, or in between.

The magnitude of the pressure wave generated in greatly affected by the stemming of the blastholes, distance between holes, and the delay time of the holes.

Normally, mortality occurs in the range of 150-psi overpressure for fish. In practice this is a 75-foot to 100-foot radius around the blasting area.

Dredging

Sea Turtles

The effects of hopper dredging on sea turtles on the Atlantic coast were analyzed by NMFS in the 1997 biological opinion entitled "The continued hopper dredging of channels and borrow areas in the southeastern United States". If it is determined that a hopper dredge will be used, the Terms and Conditions of this opinion will be applied to the project. If a cutterhead or clamshell dredge is used, based on a finding in the November 25, 1991 biological opinion between NMFS and the Corps that states:

> "Pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have to approach the cutterhead and be caught in the suction. This type of behavior would appear unlikely, but may be possible. Presently, NMFS has determined that pipeline dredges are unlikely to adversely effect sea turtles".

Based on this determination, the Corps finds that use of a cutterhead dredge may effect, but is not likely to adversely affect sea turtles. If a clamshell dredge is used, there is no suction to capture a sea turtle and the turtle would have to be caught between the two halved of the clamshell. While this is not impossible, it is improbable. The Corps has also determined that use of a clamshell dredge may effect, but is not likely to adversely affect sea turtles.

Smalltooth sawfish

The smalltooth sawfish may be affected by dredging nearshore areas in channels that are currently suitable habitats (areas of sand and/or mud bottoms less than 30 feet in depth) and by blasting if there is an animal present in the blast zone at time of detonations, a stunned or damaged animal may be captured by the clamshell dredge if it could not move out of the way.

Johnson's Seagrass

Dredging will result in the removal of approximately 2.37 acres of seagrass beds where *H. johnsonii* is the sole constituent or associate of other seagrass species in the Intracoastal Waterway and Dania Cutoff Canal. This impact will include the direct removal of *H. johnsonii*. Changes in bottom depth through deepening and widening efforts within the Port is expected to make resulting habitats unsuitable for re-colonization of *H. johnsonii*. It is not known if *H. johnsonii* in areas adjacent to dredging zones would be resilient to changes in water quality or to impacts resulting from deposition of sediments on blades.

Indirect Effects

Sea Turtles

Since beaches of John U. Lloyd SRA provide important nesting areas for three sea turtle species, the project area comprises important resources for turtles. Removal of sections of hardbottom, reef, and seagrass habitats will eliminate potential foraging habitat for juvenile sea turtles. The reduction in such habitat may slightly decrease the carrying capacity of the region for turtles. Also, since these habitats are also utilized as refugia for hatchling turtles, an increase in predation may be anticipated.

Finally, dredge activities and associated disturbances (noise, lights, etc.) offshore may interrupt the movement of turtles swimming toward or away from nesting beaches. In fact, the highest potential impact to sea turtles may be the use of explosives to remove areas of rock within the Entrance and Southport Access Channels. It is extremely likely that both the pressure and noise associated with blasting will physically damage sensory mechanisms and other physiological functions of individual sea turtles.

Johnson's seagrass
Areas of Johnson's seagrass adjacent to construction activities may be temporarily affected by increased turbidity and lower water clarity during construction.

Effect Determination
The Corps has determined that the proposed expansion of Port Everglades may adversely affect listed and proposed species within the action area and requests initiation of formal consultation with NMFS.

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Planning Division
Environmental Branch

Ms. Georgia Cranmore
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
9721 Executive Center Drive North
St. Petersburg, Florida 33702

Dear Ms. Cranmore:

The U.S. Army Corps of Engineers (Corps), Jacksonville District proposes to conduct a feasibility study to assess Federal interest in navigation improvements throughout Port Everglades. An evaluation of benefits, costs, and environmental impacts determines Federal interest. This Feasibility Study was authorized by a resolution of the House Committee on Transportation dated May 9, 1996.

The Recommended Plan main elements include: widening and deepening (to -53/-50 feet) the Outer Entrance Channel, deepening the Inner Entrance Channel and Main Turning Basin to -50 feet, widening and deepening (to -47 feet) the Southport Access Channel, widening and deepening (to -32 feet) the Dania Cutoff Canal, constructing a Turning Basin at the intersection of the Dania Cutoff Canal and the Southport Access Channel at -32 feet, deepening a portion of the South Turning Basin to -44 feet, and widening and deepening (to -47 feet) the Turning Notch. Other significant construction items include relocation of the U.S. Coast Guard (USCG) Basin easterly within essentially USCG property, port facility construction, and environmental mitigation.

Enclosed please find the Corps' biological assessment of the effects of the proposed project on listed species and marine mammals in the action area and a copy of the draft Environmental Impact Statement prepared for this proposed project.

We request initiation of consultation under section 7 of the Endangered Species Act concerning the effects of the proposed activities on the smalltooth sawfish, green, hawksbill, Kemp's ridley and loggerhead sea turtles and Johnson's seagrass. We also request an initiation of consultation under the Marine Mammal Protection Act of 1972 concerning effects of the proposed activities on marine mammals within the action area.

If you have any questions, please contact Ms. Terri Jordan at 904-899-5195 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Jordan/CESAJ-PD-EA/3453/
McAdams/CESAJ-PD-EA
Dugger/CESAJ-PD-E
Scarborough/CESAJ-DP-C
Strain/CESAJ-PD-P
Duck/CESAJ-PD

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BIOLOGICAL ASSESSMENT
PORT EVERGLADES NAVIGATION PROJECT
BROWARD COUNTY, FLORIDA

Description of the Proposed Action

The U.S. Army Corps of Engineers (Corps) proposes to expand and deepen Port Everglades Harbor. A detailed description of the proposed project and all alternatives considered under the Feasibility Study are evaluated in the pending Draft Environmental Impact Statement. Broward County Port Department requested that the Corps study the feasibility of widening and deepening most of the major channels and basins within Port Everglades. Four major improvement goals were identified. 1) Improve transit in the Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB) and Southport Access Channel (SAC) to accommodate liquid bulk, cruise, and container vessels; 2) Develop the Dania Cutoff Canal (DCC) to accommodate mid-size vessels; 3) Deepen the North Turning Basin to accommodate Panamax size container ships; and 4) Improve turning and berthing in the Turning Notch.

The purpose of the proposed action is to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment. The proposed action resulted from a comprehensive analysis of all the existing and future commercial vessel transit needs within the port. This economic analysis has shown that improvements to most of the major Federal and non-Federal channels and basins are required to achieve efficient transit of the existing fleet, and to accommodate the future fleet. Substantial liquid bulk cargo cost savings can be achieved by deepening the OEC, IEC, and MTB. Widening of the OEC flare will allow safer transit for all the larger commercial vessels that experience sometimes troublesome cross currents at the channel entrance. Removal of the Widener Shoal and widening of the SAC allows for more efficient and safer transits of containerized cargo vessels past the Knuckles restriction where new generation cruise vessels are expected to be berthed. Lengthening and deepening of the TN will provide turning possibilities for larger vessels and will provide critical berthing for containerized cargo vessels. Deepening of the STB will allow for more efficient use Berths 16-18 by allowing Panamax vessel calls. Finally, widening and deepening of the DCC (in addition to a turning basin located adjacent to the SAC) will allow for relocation of smaller and midsize container, roll on/roll off (ro/ro) vessels, and general cargo traffic, thereby reducing congestion in the areas serviced by larger vessels.

The Corps expects the construction to be performed using a variety of methods including blasting and dredging with a cutterhead, clamshell, hopper or other type of dredge. Any blasting that will occur within the project will be confined blasting. Confined blasting is defined as a blast where the explosives had been placed in a hole bored into the rock substrate and capped with 3-4 feet of crushed rock known as "stemming". Stemming forces the explosive blast downward into the rock instead of allowing the blast to expand into the water column.

Action Area

The Port Everglades Harbor is a major seaport located on the southeast coast of Florida, approximately 27 nautical miles (nm) north of Miami Harbor. The Harbor lies adjacent to cities of Dania and Fort Lauderdale (Broward County), with immediate access to the Atlantic Ocean and the Intracoastal Waterway. The entrance of the Port is approximately 27 nautical miles north of Miami Harbor, Florida and 301 nautical miles south of Jacksonville Harbor, Florida. **Figure 1** shows major features located within and surrounding the project site.

Protected Species Included in this Assessment

Of the listed and protected species under NMFS jurisdiction occurring in the action area, the Corps believes that the green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), smalltooth sawfish (*Pristis pectinata*), Kemp's ridley turtle (*Lepidochelys kempii*), Hawksbill sea turtle (*Eretmochelys imbricata*), Johnson's seagrass (*Halophila johnsonii*) may be adversely affected by the implementation of the Navigation Project.

Additional endangered species that are known to occur along the Atlantic coast include the finback (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), and sperm (*Physeter macrocephalus*) whales, and the leatherback sea turtle (*Dermochelys coriacea*). The Corps has determined that these species are unlikely to be adversely affected by the proposed construction activities.

The endangered Florida manatee (*Trichecus manatus*) also occurs with the action area and the Corps has initiated consultation with the U.S. Fish and Wildlife Service concerning the effects of the proposed action on that species.

Status and Distribution of the Species

Green Turtle

Green turtles are distributed circumglobally. In the western Atlantic they range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean, but are considered rare north of Cape Hatteras (Wynne and Schwartz, 1999). Several major nesting assemblages have been identified and studied in the western Atlantic (Peters 1954; Carr and Ogren, 1960; Carr *et al.*, 1978). Most green turtle nesting in the continental United States occurs on the Atlantic Coast of Florida (Ehrhart 1979). Green turtles are the largest of the hard-shelled sea turtles. Adult male green turtles are smaller than adult females whose lengths range from 92 to 110 cm (36 to 43 in.) and weights range from 119 to 182 kg (200 to 300 lbs). Their heads are small compared to other sea turtles and the biting edge of their lower jaws is serrated.

Green turtles have a more tropical distribution than loggerhead turtles; they are generally found in waters between the northern and southern 20°C isotherms (Hirth 1971). Green turtles, like most other sea turtles, are distributed more widely in the summer when warmer water temperatures allow them to migrate north along the Atlantic coast of North America. In the summer, green turtles are found around the U.S. Virgin Islands, Puerto Rico, and continental North America from Texas to Massachusetts. Immature greens can be distributed in estuarine and coastal waters from Long Island Sound, Chesapeake Bay, and the North Carolina sounds south throughout the tropics (Musick and Limpus, 1997). In the United States, green turtles nest primarily along the Atlantic Coast of Florida, the U.S. Virgin Islands, and Puerto Rico. In the winter, as water temperatures decline, green turtles that are found north of Florida begin to migrate south into subtropical and tropical water.

The green turtle was protected under the ESA in 1978; breeding populations off the coast of Florida and the Pacific coast of Mexico are listed as endangered, all other populations are listed as threatened. The greatest threat to this species is the loss of its nesting habitat. Throughout the tropical and subtropical distribution of this species, beaches are eroded, armored, renourished, or converted for residential or commercial purposes. Green turtles are also threatened by fibropapilloma disease; incidental takes in commercial or recreational fishing gear; and poaching (although poaching is infrequent in the United States). Green turtles are harvested in some nations for food, leather, and jewelry. Green turtles are also threatened by natural causes including hurricanes and predation by exotic species (fire ants, raccoons (*Procyon lotor*) and opossums (*Didelphus virginiana*)) and by poaching of eggs and nesting females.

There is evidence that green turtle nesting has been on the increase during the past decade. Recently, green turtle nesting occurred on Bald Head Island, North Carolina just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. Increased nesting has also been observed along the Atlantic Coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Certain Florida nesting beaches where most green turtle nesting activity occurs have been designated index beaches. Index beaches were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the six years of regular monitoring since establishment of the index beaches in 1989. Recent population estimates for the western Atlantic area are not available.

While nesting activity is obviously important in determining population distributions, the remaining portion of the green turtle's life is spent on the foraging grounds. Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida, the northwestern coast of the Yucatan Peninsula, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach. Pelagic juveniles are assumed to be omnivorous, but with a strong tendency toward carnivory during early life stages. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas, shifting to a chiefly herbivorous diet (Bjorndal 1997). Post-pelagic green turtles feed primarily on sea grasses and benthic algae but also consume jellyfish, salps, and sponges. In the western Atlantic region, the summer developmental habitat encompasses estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and North Carolina sounds, and south throughout the tropics (Musick and Limpus, 1997). Like loggerheads and Kemp's ridleys, green sea turtles that use northern waters during the summer must return to southern waters in autumn, or face the risk of cold stunning.

General human impacts and entanglement

Anthropogenic impacts to the green sea turtle population are similar to those discussed above for other sea turtles species. Sea sampling coverage in the pelagic driftnet, pelagic longline, scallop dredge, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles. In addition, the NMFS/Northeast Fisheries Science Center (NEFSC) is conducting a review of bycatch levels and patterns in all fisheries in the western Atlantic for which observer data is available. Bycatch estimates will be made for all fisheries for which sample sizes are sufficiently large to permit reasonable statistical analysis. This will be compiled into an assessment report. Until that analysis is completed, the only information on the magnitude of takes available for fisheries in the action area are unextrapolated numbers of observed takes from the sea sampling data. Preliminary sea sampling data summary (1994-1998) shows the following total take of green turtles: one (anchored gillnet), two (pelagic driftnet), and two (pelagic longline). Stranding reports indicate that between 200-300 green turtles strand annually from a variety of causes (Sea Turtle Stranding and Salvage Network, unpublished data). As with the other species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of other mortality.

In 1998, NMFS designated the waters surrounding the islands of Culebra, Puerto Rico as critical habitat for the green turtle. This area supports major seagrass beds and reefs that provide forage and shelter habitat.

Loggerhead Turtle
The loggerhead sea turtle was listed as threatened under the ESA on July 28, 1978. Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans and are the most abundant species of sea turtle occurring in U.S. waters. Loggerhead sea turtles concentrate their nesting in the north and south temperate zones and subtropics, but generally avoid nesting in tropical areas of Central America, northern South America, and the Old World (NRC 1990). The largest known nesting aggregation of loggerhead sea turtles occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani, 1982). In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the gulf coast of Florida. The best scientific and commercial data available on the genetics of loggerhead sea turtles suggests there are four major subpopulations of loggerhead sea turtles in the northwest Atlantic: (1) a northern nesting subpopulation that occurs from North Carolina to northeast Florida, about 29° N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); and (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez 1990)(approximately 1,000 nests in 1998)(TEWG 2000). This biological opinion will focus on the northwest Atlantic subpopulations of loggerhead sea turtles, which occur in the action area.

Although NMFS and FWS have not completed the administrative processes necessary to formally recognize populations or subpopulations of loggerhead sea turtles, these sea turtles are generally grouped by nesting locations. Based on the most recent reviews of the best scientific and commercial data on the population genetics of loggerhead sea turtles and analyses of their population trends (TEWG, 1998; TEWG 2000), NMFS and FWS treat these loggerhead turtle nesting aggregations as distinct subpopulations whose survival and recovery is critical to the survival and recovery of the species. Further, any action that appreciably reduced the likelihood that one or more of these nesting aggregations would survive and recover would appreciably reduce the species' likelihood of survival and recovery in the wild. Consequently, this biological opinion will focus on the four nesting aggregations of loggerhead sea turtles identified in the preceding paragraph (which occur in the action area) and treat them as subpopulations for the purposes of this analysis. Natal homing to the nesting beach provides the genetic barrier between these subpopulations, preventing recolonization from turtles from other nesting beaches. The importance of maintaining these subpopulations in the wild is shown by the many examples of extirpated nesting assemblages in the world. In addition, recent fine-scale analysis of mtDNA work from Florida rookeries indicate that population separations begin to appear between nesting beaches separated by more than 50-100 km of coastline that does not host nesting (Francisco *et al.* 2000) and tagging studies are consistent with this result (Richardson 1982, Ehrhart 1979, LeBuff 1990, CMTTP: in NMFS SEFSC 2001). Nest site relocations greater than 100 km occur, but generally are rare (Ehrhart 1979; LeBuff 1974, 1990; CMTTP; Bjorndal *et al.* 1983 : *in* NMFS SEFSC 2001).

The loggerhead sea turtles in the action area are likely to represent differing proportions of the four western Atlantic subpopulations. Although the northern nesting subpopulation produces about 9% of the loggerhead nests, they comprise more of the loggerhead sea turtles found in foraging areas from the northeastern U.S. to Georgia: between 25 and 59 percent of the loggerhead sea turtles in this area are from the northern subpopulation (NMFS SEFSC 2001; Bass *et al.*, 1998; Norrgard, 1995; Rankin-Baransky, 1997; Sears 1994, Sears *et al.*, 1995). In the Carolinas, the northern subpopulation is estimated to make up from 25% to 28% of the loggerheads (NMFS SEFSC 2001; Bass *et al.* 1998, 1999). About ten percent of the loggerhead sea turtles in foraging areas off the Atlantic coast of central Florida are from the northern subpopulation (Witzell *et al.*, in prep). In the Gulf of Mexico, most of the loggerhead sea turtles in foraging areas will be from the South Florida subpopulation, although the northern subpopulation may represent about 10% of the loggerhead sea turtles in the Gulf (Bass pers. comm). In the Mediterranean Sea, about 45 - 47 percent of the pelagic loggerheads are from the South Florida subpopulation and about two percent are from the northern subpopulation, while only about 51% originated from Mediterranean nesting beaches (Laurent *et al.*, 1998). In the vicinity of the Azores and Madiera Archipelagoes, about 19% of the pelagic loggerheads are from the northern subpopulation, about 71% are from the South Florida subpopulation, and about 11% are from the Yucatán subpopulation (Bolten *et al.*, 1998).

Loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years. Turtles in this life history stage are called "pelagic immatures" and are best known from the eastern Atlantic near the Azores and Madeira and have been reported from the Mediterranean as well as the eastern Caribbean (Bjorndal *et al.*, in press). Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm SCL they recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico.

Benthic immatures have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico (R. Márquez-M., pers. comm.). Large benthic immature loggerheads (70-91 cm) represent a larger proportion of the strandings and in-water captures (Schroeder *et al.*, 1998) along the south and western coasts of Florida as compared with the rest of the coast, but it is not known whether the larger animals actually are more abundant in these areas or just more abundant within the area relative to the smaller turtles.

Benthic immature loggerheads foraging in northeastern U.S. waters are known to migrate southward in the fall as water temperatures cool (Epperly *et al.*, 1995; Keinath, 1993; Morreale and Standora, 1999; Shoop and Kenney, 1992), and migrate northward in spring. Given an estimated age at maturity of 21-35 years (Frazer and Ehrhart, 1985; Frazer and Limpus, 1998), the benthic immature stage must be at least 10-25 years long. NMFS SEFSC 2001 analyses conclude that juvenile stages have the highest elasticity and maintaining or decreasing current sources of mortality in those stages will have the greatest impact on maintaining or increasing population growth rates.

Although loggerhead sea turtles are most vulnerable to pelagic longlines during their pelagic, immature life history stage, there is some evidence that benthic immatures may also be captured, injured, or killed by pelagic fisheries. Recent studies have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic immatures, followed by permanent settlement into benthic environments. Some may not totally circumnavigate the North Atlantic. In addition, some of these turtles may either remain in the pelagic habitat in the North Atlantic longer than hypothesized or they may move back and forth between pelagic and coastal habitats (Witzell in prep.). Any loggerhead sea turtles that follow this developmental model would be adversely affected by shark gill nets and shark bottom longlines set in coastal waters, in addition to pelagic longlines.

Adult loggerhead sea turtles have been reported throughout the range of this species in the U.S. and throughout the Caribbean Sea. As discussed in the beginning of this section, they nest primarily from North Carolina southward to Florida with additional nesting assemblages in the Florida Panhandle and on the Yucatán Peninsula. Non-nesting, adult female loggerheads are reported throughout the U.S. and Caribbean Sea; however, little is known about the distribution of adult males who are seasonally abundant near nesting beaches during the nesting season. Aerial surveys suggest that loggerheads (benthic immatures and adults) in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Based on the data available, it is not possible to estimate the size of the loggerhead sea turtle population in the U.S. or its territorial waters. There is, however, general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage. Nesting data collected on index nesting beaches in the U.S. from 1989-1998 represent the best dataset available to index the population size of loggerhead sea turtles. However, an important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates. Given this, between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,016-89,034 annually, representing, on average, an adult female population of 44,780 [(nests/4.1) * 2.5]. On average, 90.7% of the nests were from the South Florida subpopulation, 8.5% were from the northern subpopulation, and 0.8% were from the Florida Panhandle subpopulation. There is limited nesting throughout the Gulf of Mexico west of Florida, but it is not known to what subpopulation they belong. Based on the above, there are only an estimated 3,800 nesting females in the northern loggerhead subpopulation. The status of this population, based on number of loggerhead nests, has been classified as stable or declining

(TEWG 2000). Another consideration adding to the vulnerability of the northern subpopulation is that NMFS scientists estimate, using genetics data from Texas, South Carolina, and North Carolina in combination with juvenile sex ratios from those states, that the northern subpopulation produces 65% males, while the Florida subpopulation is estimated to produce 80% females (NMFS SEFSC 2001, Part I).

From a global perspective, the southeastern U.S. nesting aggregation is critical to the survival of this species: it is second in size only to the nesting aggregations in the Arabian Sea off Oman and represents about 35 and 40 percent of the nests of this species. The status of the Oman nesting beaches has not been evaluated recently, but they are located in a part of the world that is vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills), the resulting risk facing this nesting aggregation and these nesting beaches is cause for considerable concern (Meylan *et al.*, 1995).

Like other sea turtles, the movements of loggerheads are influenced by water temperature. Since they are limited by water temperatures, sea turtles do not usually appear on the summer foraging grounds until June, but are found in Virginia as early as April. The large majority leaves the Gulf of Maine by mid-September but may remain in these areas until as late as November and December. Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks (Wynne and Schwartz, 1999). Under certain conditions they may also scavenge fish, particularly if they are easy to catch (e.g., caught in nets) (NMFS and USFWS, 1991).

General Human-related Impacts
Loggerhead sea turtles face a number of threats in the marine environment, including oil and gas exploration, development, and transportation; marine pollution; trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries; underwater explosions; dredging, offshore artificial lighting; power plant entrapment; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; and poaching. On their nesting beaches in the U.S., loggerhead sea turtles are threatened with beach erosion, armoring, and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; exotic dune and beach vegetation; predation by exotic species such as fire ants, raccoons (*Procyon lotor*), armadillos (*Dasypus novemcinctus*), opossums (*Didelphus virginiana*); and poaching.

Loggerhead sea turtles also face numerous threats from natural causes. For example, there is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November) and loggerhead sea turtle nesting season (March to November); hurricanes can have potentially disastrous effects on the survival of eggs in sea turtle nests. In 1992, Hurricane Andrew affected turtle nests over a 90-mile length of coastal Florida; all of the eggs were destroyed by storm surges on beaches that were closest to the eye of this hurricane (Milton *et al.*, 1992). On Fisher Island near Miami, Florida, 69 % of the eggs did not hatch after Hurricane Andrew, probably because they were drowned by the storm surge. Nests from the northern subpopulation were destroyed by hurricanes, which made landfall in North Carolina in the mid to late 1990's. Sand accretion and rainfall that result from these storms can appreciably reduce hatchling success. These natural phenomena probably have significant, adverse effects on the size of specific year classes; particularly given the increasing frequency and intensity of hurricanes in the Caribbean Sea and northwest Atlantic Ocean.

Status and Trend of Loggerhead Sea Turtles
The most recent work updating what is known regarding status and trends of loggerhead sea turtles is contained in NMFS SEFSC 2001. The recovery plan for this species (NMFS and USFWS 1991) state that southeastern U.S. loggerheads can be considered for delisting if, over a period of 25 years, adult female populations in Florida are increasing and there is a return to pre-listing annual nest numbers totaling 12,800 for North Carolina, South Carolina, and Georgia combined. This equates to approximately 3,100 nesting females per year at 4.1 nests per female per season. NMFS SEFSC 2001 concludes, "...nesting trends indicate that the numbers of females associated with the South Florida subpopulation are increasing. Likewise, nesting trend analyses indicate potentially increasing nest numbers in the northern subpopulation" (TEWG 2000). However, NMFS SEFSC 2001 also cautions that given the uncertainties in survival rates (of the different life stages, particularly the pelagic immature stage), and the stochastic nature of populations, population trajectories should not be used now to quantitatively assess when the northern subpopulation may achieve 3,100 nesting females.

Several published reports have presented the problems facing long-lived species that delay sexual maturity in a world replete with threats from a modern, human population (Crouse *et al.*, 1987, Crowder *et al.*, 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high, annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes. This general rule applies to sea turtles, particularly loggerhead sea turtles, because the rule originated in studies of sea turtles (Crouse *et al.*, 1987, Crowder *et al.*, 1994, Crouse 1999). Heppell *et al.* (in prep.) specifically showed that the growth of the loggerhead sea turtle population was particularly sensitive to changes in the annual survival of both juvenile and adult sea turtles and that the adverse effects of the pelagic longline fishery on loggerheads from the pelagic immature phase appeared critical to the survival and recovery of the species. Crouse (1999) concluded that relatively small changes in annual survival rates of both juvenile and adult loggerhead sea turtles would adversely affect large segments of the total loggerhead sea turtle population.

The four major subpopulations of loggerhead sea turtles in the northwest Atlantic, northern, south Florida, Florida panhandle, and Yucatán are all subject to fluctuations in the number of young produced annually because of natural phenomena like hurricanes as well as human-related activities. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast (in areas like Merrit Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection and probably cause fluctuations in sea turtle nesting success. Sea turtles nesting in the southern and central counties of Florida can be affected by beach armoring, beach renourishment, beach cleaning, artificial lighting, predation, and poaching (NMFS & FWS 1991).

As discussed previously, the survival of juvenile loggerhead sea turtles is threatened by a completely different set of threats from human activity once they migrate to the ocean. Pelagic immature loggerhead sea turtles from these four subpopulations circumnavigate the North

Atlantic over several years (Carr 1987, Bjorndal 1994). During that period, they are exposed to a series of long-line fisheries that include an Azorean long-line fleet, a Spanish long-line fleet, and various fleets in the Mediterranean Sea (Aguilar *et al.*, 1995, Bolten *et al.*, 1994, Crouse 1999). Based on their proportional distribution, the capture of immature loggerhead sea turtles in long-line fleets in the Azores and Madiera Archipelagoes and the Mediterranean Sea will have a significant, adverse effect on the annual survival rates of juvenile loggerhead sea turtles from the western Atlantic subpopulations, with a disproportionately large effect on the northern subpopulation that may be significant at the population level.

In waters off coastal U.S., a suite of fisheries in Federal and State waters threatens the survival of juvenile loggerhead sea turtles. Loggerhead turtles are captured, injured, or killed in shrimp fisheries off the Atlantic coast; along the southeastern Atlantic coast, loggerhead turtle populations are declining where shrimp fishing is intense off the nesting beaches (NRC 1990). Conversely these nesting populations do not appear to be declining where nearshore shrimping effort is low or absent. The management of shrimp harvest in the Gulf of Mexico demonstrates the correlation between shrimp trawling and impacts to sea turtles. Waters out to 200nm are closed to shrimp fishing off of Texas each year for approximately a three-month period (mid-May through mid-July) to allow shrimp to migrate out of estuarine waters; sea turtle strandings decline dramatically during this period (NMFS, STSSN unpublished data). Loggerhead sea turtles are captured in fixed pound-net gear in the Long Island Sound, in pound-net gear and trawls in summer flounder and other finfish fisheries in the mid-Atlantic and Chesapeake Bay, in gill net fisheries in the mid-Atlantic and elsewhere, in fisheries for monkfish and for spiny dogfish, and in northeast sink gillnet fisheries (see further discussion in the *Environmental Baseline* of this Opinion). Witzell (1999) compiled data on capture rates of loggerhead and leatherback turtles in U.S. longline fisheries in the Caribbean and northwest Atlantic; the cumulative takes of these fisheries approach those of the U.S. shrimp fishing fleet (Crouse 1999, NRC 1990).

Hawksbill Turtle

Hawksbill turtles are small to medium-sized sea turtles. They are distinguished from other sea turtles by two pairs of prefrontal scales; thick carapace scutes that overlap towards the turtle's posterior, four pairs of costal scutes; and two claws on each flipper. There are two recognized subspecies of hawksbill sea turtles, one in the Atlantic Ocean (ssp. *imbricata*) and one in the Pacific Ocean (ssp. *squamata*).

Hawksbill turtles use different habitats for different stages in their life cycles. Post-hatchling hawksbill turtles remain in pelagic environments to take shelter in weedlines that accumulate at convergence points. Juvenile hawksbill turtles (those with carapace lengths of 20-25 cm) re-enter coastal waters where they become residents of coral reefs, which provide sponges for food and ledges, and caves for shelter. Hawksbill turtles are also found around rocky outcrops, high-energy shoals, and mangrove-fringed bays and estuaries (particularly in areas where coral reefs do not occur). Hawksbill turtles remain in coastal waters when they become subadults and adults.

Hawksbill turtles occur in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. In the United States, hawksbill sea turtles have been recorded in all states along the Gulf of Mexico and along the Atlantic coast to Massachusetts. In the United States, hawksbill turtles nest on the Atlantic coast of Florida, the U.S. Virgin Islands, and Puerto Rico. Hawksbill turtles nests in Florida are relatively rare, but Richardson *et al.* (1989) estimated that the Caribbean and Atlantic portions of the U.S. support a minimum of 650 hawksbill turtle nests each year

The hawksbill turtle was listed as an endangered species on June 2, 1970 (35 FR 8491). The hawksbill turtle has been endangered by significant modifications of its coastal habitat throughout its range. The National Research Council (1990), and NMFS/FWS (1993) have published general overviews of the effects of habitat alteration on hawksbill turtles. In the U.S. Virgin Islands, problems such as egg poaching, domestic animals, beach driving, litter, and recreational use of beaches have presented problems for nesting hawksbill turtles. In addition, beachfront lights appear to pose a serious problem for hatchling hawksbill (and other) turtles in the U.S. Virgin Islands. At sea, activities that damage coral reefs and other habitats that are important to the hawksbill turtle threaten the continued existence of this species. Hawksbill turtles are also threatened by natural causes including hurricanes and predation by exotic species (fire ants, raccoons (*Procyon lotor*) and opossums (*Didelphus virginiana*)) and by poaching of eggs and nesting females.

In 1998, NMFS designated the waters surrounding Mona and Monito Islands, Puerto Rico as critical habitat for the hawksbill turtle.

Kemp's Ridley Sea Turtle

Of the seven extant species of sea turtles of the world, the Kemp's ridley has declined to the lowest population level. The Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempi*) (USFWS and NMFS 1992) contains a description of the natural history, taxonomy, and distribution of the Kemp's ridley turtle. Kemp's ridleys nest in daytime aggregations known as arribadas. The primarily arribada in the Gulf of Mexico is located at Rancho Nuevo, a stretch of beach in Mexico. Most of the population of adult females nest in this single locality (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the early 1970's, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid-1980s. Recent observations of increased nesting suggest that the decline in the ridley population has stopped and there is cautious optimism that the population is now increasing.

Research being conducted by Texas A&M University has resulted in the intentional live-capture of hundreds of Kemp's ridleys at Sabine Pass and the entrance to Galveston Bay. Between 1989 and 1993, 50 of these turtles were tracked (using satellite and radio telemetry) by biologists with the NMFS Galveston Laboratory. The tracking study was designed to characterize sea turtle habitat and to identify small and large-scale migration patterns. Preliminary analysis of the data collected during these studies suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NMFS Galveston Laboratory, pers. comm.).

After unprecedented numbers of Kemp's ridley carcasses were reported from Texas and Louisiana beaches during periods of high levels of shrimping effort, NMFS established a team of population biologists, sea turtle scientists, and managers, known as the Turtle Expert Working Group (TEWG) to conduct a status assessment of sea turtle populations. Analyses conducted by the group have indicated that the Kemp's ridley population is in the early stages of recovery; however, strandings in some years have increased at rates higher than the rate of increase in the Kemp's population (TEWG 1998). While many of the stranded turtles observed in recent years in Texas and Louisiana are believed to have been incidentally taken in the shrimp fishery, other sources of mortality exist in these waters. These stranding events illustrate the vulnerability of Kemp's ridley and loggerhead turtles to the impacts of human activities in nearshore Gulf of Mexico waters.

The TEWG (1998) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the TEWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20-60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the U.S. Fish and Wildlife Service (FWS) and Mexico's Instituto Nacional de Pesca to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of turtle excluder devices (TEDs). Adult ridley numbers have now grown from a low of approximately 1,050 adults producing 702 nests in 1985, to greater than 3,000 adults producing 1,940 nests in 1995 and about 3,400 nests in 1999.

The TEWG (1998) was unable to estimate the total population size and current mortality rates for the Kemp's ridley population. However, the TEWG listed a number of preliminary conclusions. The TEWG indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Over the period 1987 to 1995, the rate of increase in the annual number of nests accelerated in a trend that would continue with enhanced hatchling production and the use of TEDs. Nesting data indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and a low of 702 nests in 1985. This trajectory of adult abundance tracks with trends in nest abundance from an estimate of 9,600 in 1966 to 1,050 in 1985. The TEWG estimated that in 1995 there were 3,000 adult ridleys. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6% to 28% from 1981 to 1989 and from 23% to 41% from 1990 to 1994. The population model in the TEWG projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. It determined that the data reviewed suggested that adult Kemp's ridley turtles were restricted somewhat to the Gulf of Mexico in shallow near shore waters, and benthic immature turtles of 20-60 cm straight line carapace length are found in nearshore coastal waters including estuaries of the Gulf of Mexico and the

Atlantic.

The TEWG (1998) identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase. However, the 1996 and 1997 nest numbers reflected a slower rate of growth, while the increase in the 1998 nesting level has been much higher and decreased in 1999. The population growth rate does not appear as steady as originally forecasted by the TEWG, but annual fluctuations, due in part to irregular internesting periods, are normal for other sea turtle populations. Also, as populations increase and expand, nesting activity would be expected to be more variable.

The area surveyed for ridley nests in Mexico was expanded in 1990 due to destruction of the primary nesting beach by Hurricane Gilbert. The TEWG (1998) assumed that the increased nesting observed particularly since 1990 was a true increase, rather than the result of expanded beach coverage. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather than an expanding ridley nesting range. As noted by TEWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's Ridley Recovery Plan.

Juvenile Kemp's ridleys use northeastern and mid-Atlantic coastal waters of the U.S. Atlantic coastline as primary developmental habitat during summer months, with shallow coastal embayments serving as important foraging grounds. Post-pelagic ridleys feed primarily on crabs, consuming a variety of species, including *Callinectes* sp., *Ovalipes* sp., *Libinia* sp., and *Cancer* sp. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal, 1997). Juvenile ridleys migrate south as water temperatures cool in fall, and are predominantly found in shallow coastal embayments along the Gulf Coast during fall and winter months.

Ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 40 centimeters in carapace length, and weighing less than 20 kilograms (Klinger and Musick 1995). Next to loggerheads, they are the second most abundant sea turtle in Virginia and Maryland waters, arriving in these areas during May and June, and migrating to more southerly waters from September to November (Keinath *et al.*, 1987; Musick and Limpus, 1997). In the Chesapeake Bay, ridleys frequently forage in shallow embayments, particularly in areas supporting submerged aquatic vegetation (Lutcavage and Musick, 1985; Bellmund *et al.*, 1987; Keinath *et al.*, 1987; Musick and Limpus, 1997). The juvenile population in Chesapeake Bay is estimated to be 211 to 1,083 turtles (Musick and Limpus, 1997).

General human impacts and entanglement

Anthropogenic impacts to the Kemp's ridley population are similar to those discussed above. Sea sampling coverage in the northeast otter trawl fishery, pelagic longline fishery, and southeast shrimp and summer flounder bottom trawl fisheries have recorded takes of Kemp's ridley turtles. As with loggerheads, a large number of Kemp's ridleys are taken in the southeast shrimp fishery each year. Kemp's ridleys were also affected by the apparent large-mesh gillnet interaction that occurred in spring off of North Carolina. A total of five carcasses were recovered from the same North Carolina beaches where 277 loggerhead carcasses were found. This is expected to be a

minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction since it is unlikely that all carcasses washed ashore.
Johnson's seagrass

Smalltooth Sawfish
All modern sawfish belong to the Suborder Pristoidea, Family Pristidae, and Genus *Pristis*. Although they are rays, sawfish appear to be more shark-like than ray-like, with only the trunk and especially the head ventrally flattened. The snout of all sawfish is extended as a long narrow flattened rostral blade with a series of transverse teeth along either edge, hence the vernacular name. Species in the genus *Pristis* are separable into two groups according to whether the caudal fin has a distinct lower lobe or not. The smalltooth sawfish, *Pristis pectinata*, is the sole known representative on the western side of the Atlantic of the group lacking a defined lower caudal lobe (NMFS, 2000).

Distribution
The smalltooth sawfish has a circumtropical distribution and has been reported from shallow coastal and estuarine habitats. In U.S. waters, *P. pectinata* historically occurred from North Carolina south through the Gulf of Mexico, where it was sympatric with the largetooth sawfish (west and south of Port Arthur, TX) (Adams and Wilson, 1995). It also was an occasional visitor to waters as far north as New York. As with all sawfishes, it is euryhaline, occurring in fresh water, nearshore estuaries and in coastal waters to depths of 25 meters.

Pristis pectinata is the largest of the sawfishes, reported to reach 760 cm while more commonly growing to 550 cm (Last and Stevens 1994). Bigelow and Schroeder (1953) reported litter size of 15-20 embryos. Overall, life history parameters for this species are largely unknown.

In the United States, smalltooth sawfish are generally a shallow water fish of inshore bars, mangrove edges, and seagrass beds, but are occasionally found in deeper coastal waters. Records indicate that smalltooth sawfish have been found in the lower reaches of the St. Johns River and the Indian River lagoonal system. Individuals have also historically been reported to migrate northward along the Atlantic seaboard in the warmer months.

Updated collection records from the Florida Museum of Natural History of the University of Florida include 13 records of *P. pectinata* from 1912 to 1998 (with one record not dated). Nine of these specimens were recorded from the Gulf of Mexico off Florida, three came from the Atlantic side of Florida, and one animal was caught in Pacific waters off Ecuador. Three additional records of smalltooth sawfish from the Atlantic coast of Florida have yet to be cataloged in this collection: one specimen is from 1979; the second is not dated (the Museum received both these fish from the Harbor Branch Oceanographic Institute); a third specimen was landed May 22, 1998 from the Indian River (Burgess, pers. comm.). There are eight reports of smalltooth sawfish along the Florida east coast in the 1990's, most from coastal rather than lagoonal areas.

General Human-related impacts
The principal habitats for smalltooth sawfish in the southeast U.S. are the shallow coastal areas and estuaries, with some specimens moving upriver in freshwater (Bigelow and Schroeder,

1953). The continued urbanization of the southeastern coastal states has resulted in substantial loss of coastal habitat through such activities as agricultural and urban development; commercial activities; dredge and fill operations; boating; erosion and diversions of freshwater run-off (SAFMC, 1998). Smalltooth sawfish may be especially vulnerable to coastal habitat degradation due to their affinity to shallow, estuarine systems. With the K-selected life history strategy of smalltooth sawfish, including slow growth, late maturation, and low fecundity, long-term commitments to habitat protection are necessary for the eventual recovery of the species.

A complete review of the factors contributing to the decline of the smalltooth sawfish can be found in the "Status Review of Smalltooth Sawfish (*Pristis pectinata*)", (NMFS, 2000) and will not be repeated in detail here.

Status and Trends of smalltooth sawfish

The smalltooth sawfish was added to the list of species as candidates under the ESA in 1991, removed in 1997, and placed back on the list again in 1999. In November 1999, NMFS received a petition from the Center of Marine Conservation requesting that this species be listed as endangered under the ESA. NMFS completed a status review for smalltooth sawfish in December 2000, and published a proposed rule to list this the U.S. population of this species as endangered under the ESA on April 16, 2001. On April 1, 2003, the National Marine Fisheries Service (NOAA Fisheries) announced its final determination to list smalltooth sawfish as an endangered species under the Endangered Species Act (ESA).

According to NMFS (2000) "The U.S. DPS of smalltooth sawfish has experienced a ninety percent curtailment of its range and severe declines in abundance. Agriculture, urban development, commercial activities, channel dredging, boating activities, and the diversion of freshwater run-off have resulted in the destruction and modification of smalltooth habitat throughout the southeastern U.S. Although habitat degradation is not likely the primary reason for the decline of smalltooth sawfish abundance and their contracted distribution, it has likely been a contributing factor. Over 50% of the U.S. human population lives within fifty miles of the ocean or Great Lakes. Migration to the coastlines for home, livelihood or recreation is predicted to increase by the year 2010 (National Ocean Service, 2000). Increases in coastal human populations will likely result in additional losses of marine habitats and increased pollution, further threatening the survival of smalltooth sawfish."

Simpfendorfer (2000) used a demographic approach to estimate intrinsic rate of natural increase and population doubling time. Since there are very limited life history data for smalltooth sawfish, much of the data (e.g. reproductive periodicity, longevity and age-at-maturity) were inferred from the more well-known largetooth sawfish. The litter size of smalltooth sawfish in the literature is given as 15 – 20 and Simpfendorfer used a mean of 17.5. However, the data on which this litter size is based are somewhat dubious. To account for uncertainty in the life-history parameters several different scenarios were tested, covering longevities from 30 to 70 years and ages-at-maturity from 10 to 27 years. The results indicated that the intrinsic rate of population increase ranged from 0.08/year to 0.13/ year, and population-doubling times ranged from 5.4 years to 8.5 years. These models assume the literature value for litter size is correct; doubling times would be longer if litter sizes are more in the range observed for largetooth sawfish (1 to 13, with a mean of 7.3). Simpfendorfer concluded:

The estimated population doubling times for smalltooth sawfish indicate that the recovery times for this population will be very long. There are no data available on the size of the remaining populations, but anecdotal information indicates that smalltooth sawfish survive today in small fragmented areas where the impact of humans, particularly from net fishing, has been less severe. Fragmenting of the population will increase the time that it takes for recovery since the demographic models used in the study above assume a single inter-breeding population. The genetic effects of recovery from very small population sizes may also impact conservation efforts. It is likely that even if an effective conservation plan can be introduced in the near future, recovery to a level where the risk of extinction is low will take decades, while recovery to pre-European settlement levels would probably take several centuries.

Johnson's Seagrass

Species Description

Johnson's seagrass was listed as threatened under the ESA on September 14, 1998 based on the results of fieldwork and a status review initiated in 1990 and is the first marine plant ever listed. Kenworthy (1993, 1997, 1999) discusses the results of the field studies and summarizes an extensive literature review and associated interviews regarding the status of Johnson's seagrass.

The species has only been found growing along approximately 200 km of coastline in southeastern Florida from Sebastian Inlet, Indian River County to northern Key Biscayne. This narrow range and apparent endemism indicates that Johnson's seagrass has the most limited geographic distribution of any seagrass in the world.

Johnson's seagrass occurs in dynamic and disjunct patches throughout its range. Growth appears to be rapid and leaf pairs have short life spans while horizontally spreading from dense apical meristems (Kenworthy 1997). Kenworthy suggested that horizontal spreading rapid growth pattern and a high biomass turnover could explain the dynamic patches observed in distribution studies. New information reviewed in Kenworthy (1999, 1997) confirms *H. johnsonii's* limited geographic distribution in patchy and vertically disjunct areas between Sebastian Inlet and northern Biscayne Bay. Surveys conducted by NMFS and Florida staff in Biscayne Bay, Florida Bay, the Florida Keys, outer Florida Bay, Puerto Rico, and the Virgin Islands provided no verifiable sightings of Johnson's seagrass outside of the range already reported.

<u>Extent of critical habitat:</u>

The northern and southern ranges of Johnson's seagrass are defined as Sebastian Inlet and central Biscayne Bay, respectively. These limits to the species' range have been designated as critical habitat for Johnson's seagrass. Within its range, Johnson's seagrass critical habitat designations have been designated for 10 areas: a portion of the Indian River Lagoon, north of the Sebastian Inlet Channel; a portion of the Indian River Lagoon, south of the Sebastian Inlet Channel; a portion of the Indian River Lagoon near the Fort Pierce Inlet; a portion of the Indian River Lagoon, north of the St. Lucie Inlet; a portion of Hobe Sound; a site on the south side of Jupiter Inlet; a site in central Lake Worth Lagoon; a site in Lake Worth Lagoon, Boynton Beach; a site in Lake Wyman, Boca Raton; and a portion of Biscayne Bay. There is no designated critical habitat within the action area.

Life History

Reproductive strategy

The species is perennial and may spread even during winter months under favorable conditions (Virnstein *et al.* 1997). Sexual reproduction in Johnson's seagrass has not been documented. Female flowers have been found; however, dedicated surveys in the Indian River Lagoon have not discovered male flowers, fertilized ovaries, fruits, or seeds either in the field or under laboratory conditions (Jewett-Smith *et al.* 1997). Searches throughout the range of Johnson's seagrass have produced the same results, suggesting that the species does not reproduce sexually or that the male flowers are difficult to observer or describe, as noted for other *Halophila* species (Kenworthy 1997). Surveys to date indicate that the incidence of female flowers appears to be much higher near the inlets leading to the Atlantic Ocean, suggesting that inlet conditions are qualitatively better for flowering than conditions further inshore (Kenworthy pers. comm. 1998). It is possible that male flowers, if they exist, occur near inlets as well. Maintenance of good water quality around inlets may be essential for promoting flowering in the Johnson's seagrass population.

Niche

The essential features of habitat appear to be adequate water quality, salinity, water clarity and stable sediments free from physical disturbance. Important habitat characteristics include shallow intertidal as well as deeper subtidal zones (2-5 m). Water transparency appears to be critical for Johnson's seagrass, limiting its distribution at depth to areas of suitable optical water quality (Kenworthy 1997). In areas in which long-term poor water and sediment quality have existed until recently, such as Lake Worth Lagoon, *H. johnsonii* appears to occur in relatively higher abundance perhaps due to the previous inability of the larger species to thrive. These studies support unconfirmed previous observations that suspended solids and tannin, which reduce light penetration and water clarity, may be important factors limiting seagrass distribution. Good water clarity is essential for *Halophila johnsonii* growth in deeper waters.

Johnson's seagrass occurs over varied depths, environmental conditions, salinities, and water quality. In tidal channels *H. johnsonii* is found in coarse sand substrates, although it has been found growing on sandy shoals, in soft mud near canals and rivers where salinity many fluctuate widely (Virnstein *et al.* 1997). Virnstein has called Johnson's seagrass a "perennial opportunistic species." Within his study areas in the Indian River Lagoon, *H. johnsonii* was found by itself, with other seagrass species, in the intertidal, and (more commonly) at the deep edge of some transects in water depths of up to 180 cm. *H. johnsonii* was found shallowly rooted on sandy shoals, in soft mud, near the mouths of canals, rivers and in shallow and deep water (Virnstein *et al.* 1997). Additionally, recent studies have documented large patches of Johnson's seagrass on flood deltas just inside Sebastian Inlet, as well as far from the influence of inlets (reported at the workshop discussed in Kenworthy, 1997). These sites encompass a wide variety of salinities, water quality, and substrates.

Competitors:

Halophila johnsonii appears to be outcompeted in ideal seagrass habitats where environmental conditions permit the larger species to thrive (Virnstein *et al.* 1997, Kenworthy 1997).

Population Dynamics

Population stability

A factor leading to the listing of *H. johnsonii* is its rareness within its extremely restricted geographic range. Johnson's seagrass is characterized by small size (it is the smallest of all of the seagrasses found within its range, averaging about 3 cm in height), fragile rhizome structure and associated high turnover rate, and is apparently reliant on vegetative means to reproduce, grow and migrate across the sea bottom. These factors make Johnson's seagrass extremely vulnerable to human or environmental impacts by reducing its capacity to repopulate an area once removed. The species and its habitat are impacted by human-related activities throughout the length its range, including bridge construction and dredging, and the species' threatened status produces new and unique challenges for the management of shallow submerged lands. Vessel traffic resulting in propeller and anchor damage, maintenance dredging, dock and marine construction, water pollution, and land use practices could require special management within critical habitat.

Population (genetic) variability:

The Boca Raton and Boynton Beach sites proposed for critical habitat designation have populations that are distinguished by a higher index of genetic variation than any of the central and northern populations examined to date (Kenworthy, 1999). These two sites represent a genetically semi-isolated group that could be the reservoir of a large part of the overall genetic variation found in the species. Information is still lacking on the geographic extent of this genetic variability.

Status and Distribution

Kenworthy (1997, 1999) summarized the newest information on Johnson's seagrass biology, distribution, and abundance and confirmed the limited range and rareness of this species within its range. Additionally, the apparent restriction of propagation through vegetative means suggests that colonization between broadly disjunct areas is likely difficult, suggesting that the species is vulnerable to becoming endangered if it is removed from large areas within its range by natural or anthropogenic means. Human impacts to Johnson's seagrass and its habitat include: (1) Vessel traffic and the resulting propeller dredging and anchor mooring; (2) dredging; (3) dock and marina construction and shading from these structures; (4) water pollution; and (5) land use practices including shoreline development, agriculture, and aquaculture.

Activities associated with recreational boat traffic account for the majority of human use associated with the proposed critical habitat areas. The destruction of the benthic community due to boating activities, propeller dredging, anchor mooring, and dock and marina construction was observed at all sites during a study by NMFS from 1990 to 1992. These activities severely disrupt the benthic habitat, breaching root systems, severing rhizomes, and significantly reducing the viability of the seagrass community. Propeller dredging and anchor mooring in shallow areas are a major disturbance to even the most robust seagrasses. This destruction is expected to worsen with the predicted increase in boating activity. Trampling of seagrass beds, a secondary effect of recreational boating, also disturbs seagrass habitat. Populations of Johnson's seagrass inhabiting shallow water and water close to inlets, where vessel traffic is concentrated, will be most affected.

The constant sedimentation patterns in and around inlets require frequent maintenance dredging, which could either directly remove essential seagrass habitat or indirectly affect it by redistributing sediments, burying plants and destabilizing the bottom structure. Altering benthic topography or burying the plants may remove them from the photic zone. Permitted dredging of channels, basins, and other in- and on-water construction projects cause loss of Johnson's seagrass and its habitat through direct removal of the plant, fragmentation of habitat, and shading. Docking facilities that, upon meeting certain provisions, are exempt from state permitting also contribute to loss of Johnson's seagrass through construction impacts and shading. Fixed add-ons to exempt docks (such as finger piers, floating docks, or boat lifts) have recently been documented as an additional source of seagrass loss due to shading (Smith and Mezich, 1999).

Decreased water transparency caused by suspended sediments, water color, and chlorophylls could have significant detrimental effects on the distribution and abundance of the deeper water populations of Johnson's seagrass. A distribution survey in Hobe and Jupiter Sounds indicates that the abundance of this seagrass diminishes in the more turbid interior portion of the lagoon where reduced light limits photosynthesis.

Other areas of concern include seagrass beds located in proximity to rivers and canal mouths where low salinity, highly colored water is discharged. Freshwater discharge into areas adjacent to seagrass beds may provoke physiological stress upon the plants by reducing the salinity levels. Additionally, colored waters released into these areas reduce the amount of sunlight available for photosynthesis by rapidly attenuating shorter wavelengths of Photosynthetically Active Radiation.

Continuing and increasing degradation of water quality due to increased land use and water management threatens the welfare of seagrass communities. Nutrient overenrichment caused by inorganic and organic nitrogen and phosphorous loading via urban and agricultural land run-off stimulates increased algal growth that may smother Johnson's seagrass, shade rooted vegetation, and diminish the oxygen content of the water. Low oxygen conditions have a demonstrated negative impact on seagrasses and associated communities.

A wide range of activities funded, authorized or carried out by Federal agencies may affect the essential habitat requirements of Johnson's seagrass. These include authorization by the COE for beach nourishment, dredging, and related activities including construction of docks and marinas; bridge construction projects funded by the Federal Highway Administration; actions by the U.S. Environmental Protection Agency and the COE to manage freshwater discharges into waterways; regulation of vessel traffic by the U.S. Coast Guard; management of national refuges and protected species by the U.S. Fish and Wildlife Service; management of vessel traffic (and other activities) by the U.S. Navy; authorization of state coastal zone management plans by NOAA's National Ocean Service, and management of commercial fishing and protected species by NMFS.

Rangewide trend:
Lamentably, there is currently insufficient information to clearly determine trends in the

Johnson's seagrass population, which was described in 1980 and has only been extensively studied during the 1990s. Generally, seagrasses within the range of Johnson's seagrass have declined in some areas and increased in others. Where multiyear mapping studies have been conducted within the Indian River Lagoon, recent increases in Johnson's seagrass have been noted but may be attributed in part to the recent increase in search effort and increased familiarity with this species (Virnstein *et al.* 1997). The authors conclude that from 1994 through 1997, no strong seasonal distribution or increases or decreases in abundance or range can be discerned.

Protected Species Surveys within the project area.
Surveys specifically targeting protected species were not conducted in the action area, however an Environmental Baseline Study and Impact Assessment were prepared. This assessment, literature reviews and consultations with NMFS serve as the basis for this biological assessment and the determination of which listed and protected species under NMFS' jurisdiction are found in the project area.

Sea Turtles
Broward County is within the normal nesting range of three species of sea turtles: the loggerhead (*Caretta caretta*), the green turtle (*Chelonia mydas*), and the leatherback (*Dermochelys coriacea*). The green sea turtle and leatherback sea turtle are both listed under the U. S. Endangered Species Act, 1973 and Chapter 370, F.S. The loggerhead turtle is listed as a threatened species (Burney and Margolis, 1999). Within the 38.6 miles of beach from the Palm Beach County line to the Dade County line a total of 2,620 sea turtle nests were found in 1999 (Burney and Margolis 1999). From 1990 through 1999, an average of 2,446 sea turtle nests were discovered on Broward County beaches. Within John U. Lloyd SRA, a total of 212 sea turtle nests were observed during 1999 (DC&A, 2002). The majority of sea turtle nesting activity occurred during the summer months of June, July and August, with nesting activity occurring as early as March and as late as September (Burney and Margolis, 1999). The waters offshore of Broward County are also habitat used for foraging and shelter for the three species listed above and possibly the hawksbill turtle (*Eretmochelys imbricata*), and the Kemp's ridley turtle (*Lepidochelys kempii*) (USACE, 2000).

Six (6) stranded threatened and endangered sea turtles have been reported within the Port boundaries: 3 loggerheads, 2 green turtles and 1 hawksbill. In addition there were 13 incidental capture records - 1 green turtle was caught on hook and line and 12 turtles (6 loggerheads, 2 green turtles, 2 hawksbills and 2 unidentified species) were caught in the power plant at Port Everglades (Wendy Teas, pers. Comm. 2002).

Johnson's Seagrass
Johnson's seagrass occurs within the project area, specifically in the Intracoastal Waterway east and south of the Main Turning Basin, and just west of the Dania Cutoff Canal, and in the Dania Cutoff Canal. Abundance and density values are low and the species is generally associated with *H. decipiens*. Johnson's seagrass also occurs south of the Dania Cutoff Canal within Whiskey Creek, along the western shore of the Intracoastal Waterway and within the West Lake Park embayment (Miller Legg, 2001). Cover-abundance and density were higher along the west shore of West Lake Park than was observed within the Port Everglades project area.

Smalltooth sawfish
This species inhabits softbottom estuarine habitats in depths generally less than 30 feet. Its former range in U.S. waters extended from Texas through Maryland. Currently, few are observed outside peninsular Florida. At least one recorded observation has occurred within the vicinity of Broward County (NMFS, 2000). Populations likely decreased due to a low intrinsic rate of natural increase, the long interval to time of reproduction, and human impacts, most notably overfishing, incidental take in nets (due in part to its body size and unusual morphology), and habitat loss (development of shoreline and nearshore habitats).

Effects of the Action on Protected Species.
As previously stated, the Corps believes that the loggerhead turtle, green turtle, smalltooth sawfish and johnson's seagrass have the potential to be effected by the proposed dredging project. The project may have the following adverse impacts on listed/protected species are:

- direct effect of blasting in the turning basin.
- direct effect of dredging activities
- indirect effects

Direct Effects
Blasting
To assess and reduce the effects of blasting on endangered, threatened and otherwise protected species, the Corps contracted with Dr. Calvin Koyna, Precision Blasting Services to review previous Corps blasting projects, recommendations of Florida Fish and Wildlife Conservation Commission (FFWCC) (then known as the Florida Department of Natural Resources) and the U.S. Fish and Wildlife Service (FWS) prepared for a harbor deepening project at Port Everglades, Florida conducted in the mid 1980's. The recommendations prepared for the project were specifically aimed at protecting endangered manatees and endangered/threatened sea turtles.

Sea turtles
Specific information regarding the likely direct impact of explosives on sea turtles is not available. Studies regarding the impacts of relatively minuscule explosives on humans noted that minor injuries such as small bruises or perforations of the intestinal tract occasionally occur well beyond ranges in which human lung damage could occur (Christian and Gaspin, 1974). Christian and Gaspin (1974) note that these minor injuries could become serious if left unattended. Sea turtles with untreated internal injuries would have increased vulnerability to predators and disease. In the Environmental Impact Statement prepared by the Navy to consider the effects of explosives used in shipshock tests, nervous system damage was cited as a possible impact to sea turtles caused by blasting. Damage of the nervous system could kill sea turtles through disorientation and subsequent drowning. The Navy's review of previous studies suggested that rigid masses such as bone (or carapace and plastron) could protect tissues beneath them; however, there are no observations available to determine whether the turtles' shells would indeed afford such protection.

Studies conducted by Klima *et al*., (1988) evaluated blasts of only approximately 42 lbs on sea turtles (4 ridleys, 4 loggerheads) placed in surface cages at varying distances from the explosion. Christian and Gaspin's (1974) estimates of safety zones for swimmers found that, beyond a cavitation area, waves reflected off a surface have reduced pressure pulses; therefore, an animal at shallow depths would be exposed to a reduced impulse. This finding, which considered only very small explosive weights, implies that the turtles in the Klima *et al.* (1988) study would be under reduced effects of the shock wave. Despite this possible lowered level of impact, 5 of 8 turtles were rendered unconscious at distances of 229 to 915 m from the detonation site. Unconscious sea turtles that are not detected, removed and rehabilitated likely have low survival rates.

Blasting will affect nearby finfish and invertebrates and cause short-term changes to the physical characteristics of the benthos. Fish and invertebrates killed or injured by the blasting may provide a short-term enhancement of foraging opportunities for green and loggerhead sea turtles. Through new recruitment and local migrations, finfish and benthic invertebrates are expected eventually to repopulate the affected area. Any modifications of the local area's environment, as far as sea turtle habitat, are not expected to be significant in the long term.

<u>Smalltooth Sawfish</u>

Blasting rock underwater produces a pressure wave in water that can produce fish mortality. Different types of fish have different mortality thresholds. This depends on whether the fish dwell near the surface, on the bottom, or in between.

The magnitude of the pressure wave generated in greatly affected by the stemming of the blastholes, distance between holes, and the delay time of the holes.

Normally, mortality occurs in the range of 150-psi overpressure for fish. In practice this is a 75-foot to 100-foot radius around the blasting area.

Dredging

<u>Sea Turtles</u>

The effects of hopper dredging on sea turtles on the Atlantic coast were analyzed by NMFS in the 1997 biological opinion entitled "The continued hopper dredging of channels and borrow areas in the southeastern United States". If it is determined that a hopper dredge will be used, the Terms and Conditions of this opinion will be applied to the project. If a cutterhead or clamshell dredge is used, based on a finding in the November 25, 1991 biological opinion between NMFS and the Corps that states:

> "Pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have to approach the cutterhead and be caught in the suction. This type of behavior would appear unlikely, but may be possible. Presently, NMFS has determined that pipeline dredges are unlikely to adversely effect sea turtles".

Based on this determination, the Corps finds that use of a cutterhead dredge may effect, but is not likely to adversely affect sea turtles. If a clamshell dredge is used, there is no suction to capture a sea turtle and the turtle would have to be caught between the two halved of the clamshell. While this is not impossible, it is improbable. The Corps has also determined that use of a clamshell dredge may effect, but is not likely to adversely affect sea turtles.

Smalltooth sawfish
The smalltooth sawfish may be affected through dredging nearshore areas in channels that are currently suitable habitats (areas of sand and/or mud bottoms less than 30 feet in depth) and by blasting if there is an animal present in the blast zone at time of detonations.

Johnson's Seagrass
Dredging will result in the removal of approximately 1.79 acres of seagrass beds where *H. johnsonii* is the sole constituent or associate of other seagrass species in the Intracoastal Waterway and Dania Cutoff Canal. This impact will include the direct removal of *H. johnsonii*. Changes in bottom depth through deepening and widening efforts within the Port is expected to make resulting habitats unsuitable for re-colonization of *H. johnsonii*. It is not known if *H. johnsonii* in areas adjacent to dredging zones would be resilient to changes in water quality or to impacts resulting from deposition of sediments on blades.

Indirect Effects
Sea Turtles
Since beaches of John U. Lloyd SRA provide important nesting areas for three sea turtle species, the project area comprises important resources for turtles. Removal of sections of hardbottom, reef, and seagrass habitats will eliminate potential foraging habitat for juvenile sea turtles. The reduction in such habitat may slightly decrease the carrying capacity of the region for turtles. Also, since these habitats are also utilized as refugia for hatchling turtles, an increase in predation may be anticipated. Finally, dredge activities and associated disturbances (noise, lights, etc.) offshore may interrupt the movement of turtles swimming toward or away from nesting beaches. In fact, the highest potential impact to sea turtles may be the use of explosives to remove areas of rock within the Entrance and Southport Access Channels. It is extremely likely that both the pressure and noise associated with blasting will physically damage sensory mechanisms and other physiological functions of individual sea turtles.

Dolphins
Dredging and construction activities in the area may alter behavior and migration routes of dolphins. Any disturbance of dolphins would be considered harassment of a marine mammal under the Marine Mammal Protection Act of 1972.

Effect Determination
The Corps has determined that the proposed expansion of Port Everglades may adversely affect listed and proposed species within the action area and requests initiation of formal consultation with NMFS.

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NMFS – Southeast Regional Office – Port Everglades Feasibility Study

ESA Consultation – Status, review and future plans April 28, 2008

*** Meeting Recorded on iPod for the record in addition to meeting notes 11am – 230pm

Attendees

- Kenneth Dugger - USACE
- Martha Robbart - Dial Cordy and Associates
- Terri Jordan - USACE
- Bob Hoffman – NMFS-PRD
- Audra Livergood – NMFS-PRD
- David Bernhart – NMFS-PRD

Agenda

1. Review Benthic Assessment – Martha. Power point will be posted o USACE FTP site with meeting notes when finalized.
2. Discussions
    a. Adequacy of the existing USACE coral survey
    b. Scope of the proposed action
    c. BO timing
    d. Possibility of conferencing on coral CH and what that entails.

Results

1. Martha presented an overview of the existing USACE Reef Survey that was conducted in March 2006 (methods), and the subsequent findings published in the Reef Report (Dial Cordy 2008).
    a. 150-m indirect impact buffer calculations based on Key West (2004-2006); Key West 2007; Broward County Shore Protection Project and the Port Everglades 1980-81 dredging monitoring reports.
    b. Hopper dredges used in Key West and Broward County; cutterhead used at Port Everglades. Hopper dredges have higher turbidity than cutterheads due to overflow.
    c. Review of towed video (2000, 2001 and 2002) and diver video (2006) collected for the project.
    d. Diver safety is a limiting factor in active Navigation channels.
    e. NMFS Interim *Acropora* protocol – 2 scales – small projects <.25 acres or large projects >.25 acres. For USACE to survey the 20 minute timed swim for all of the 106 acres (.43 sq kms) – 430, 000 sq meters = 430 survey sites. Assuming you can perform 5-10 survey lines a day (an active shipping channel greatly limits access) = 9-17 work weeks with perfect weather for just *Acropora* surveys – not including any other hardbottom

characterization efforts that would be needed for the project. No current documentation protocol included in the existing protocol.

i. USACE Recommendations – Port Everglades is not only project with this problem. Miami, Key West, Palm Beach all have projects with scales greater than .25 acres. Key West did drift dives during the 2004-2006 and 2007 construction. USACE recommends that a towed-video survey method for the initial survey effort to identify presence absence. You can make scale as tight as you need it. After video is complete, if *Acropora* colonies are identified – then diver assessment can be performed o the identified colonies. The towed video also creates permanent record that any one can review (the DVD of the video). Restrict systems to digital GPS with coordinates on the video to ensure location data.

ii. NMFS recommends focusing *Acropora* survey effort on the nearshore ridge complex since we know this is suitable habitat for staghorn coral (e.g., JUL6). NMFS recommends the highest density of transects on the nearshore ridge complex, followed by the inner, middle, and outer reefs, respectively. Number of transects needed for a representative sample will need to be coordinated with other NMFS staff (Dr. Margaret Miller, Dr. Lisamarie Carrubba, and Jennifer Moore).

f. USACE survey was never intended to be an *Acropora* survey. It was designed to be a direct impact characterization in the 2nd and 3rd reefs only.

2. Discussions

a. Critical Habitat Designation – Port Everglades – all 106 acres of direct and indirect impacts = .005% of the proposed CH for the Florida Unit (8,000+ sq kms). This is a conservative number. It is based on the total of the Florida Unit – all habitats (sand, turf, etc) and the complete footprint of all habitats of the project area (previously impacted area, sand, turf, etc).

b. Ultimate goal – NMFS provides USACE with a biological opinion. NMFS major concern is having a preferred alternative. NMFS would prefer to not have to complete a Biop, and then go back and have to do another in a year or so. USACE must finish an EIS to finish Feasibility. That EIS must complete an ESA consultation, this is Corps regulation requirement. The ESA consultation is recommended to be in the Draft EIS, however it is required for the Final EIS. The ROD can not be signed without the ESA consult, thus the Feasibility Study can not be completed and submitted to Congress for authorization. NMFS would be more comfortable with waiting until the DEIS is released to the public before beginning the ESA consultation. USACE agrees that this is an acceptable method for the completion of the ESA consultation.

c. Mangrove removal from the Turning Notch and the effect on smalltooth sawfish. Blasting areas will include Main Turning Basin, South Turning Basin and Southport Access channel. USACE is using the same blasting protocol as used in Miami Harbor with confined blasts with stemming, and a specific number of observers. Those will all be included in the proposed action. The TN mangroves are mature. NMFS had some confusion with the TN impacts in 1989 and with the mitigation areas for the 89 TN dredging o the western edge of JUL (east side of SAC). No rip-rap breaks exist in the TN rip-rap. There are breaks at the JUL mangroves, but n breaks exist in the TN rip rap. There is tidal access from the northern side of the TN using a mosquito ditch. NMFS has requested that USACE put the Env. Friendly bulkhead with rip-rap in the TN and include breaks in the rip-rap to allow potential access by sawfish into the mangroves to the north of the TN that they currently have n access into.

d. USACE has committed to relocate corals greater than 12 inches in size from the direct impact areas. USACE has committed to relocate ANY *Acropora,* visible to the naked eye found in the direct impact area, without regard to size.

e. Planning, Engineering and Design Phase (referred to as "PED") *Acropora* survey – using the towed video survey would be performed on the 150-meter indirect effect area as well as the direct impact area. Discussions included the locations of JUL-6 and the presences of the *Acropora* there. Most of the *Acropora* that is prolific in Broward is being found o the nearshore ridge complex. For future survey and monitoring work – NMFS would like to see a focus on the nearshore ridge complex to ensure that any effects on *Acropora* near the channel are documented. Clarify what direct and indirect impacts are defined as by the USACE document. Direct impacts – physical removal of the habitat or the species. Indirect impacts – siltation and shading from dredge generated turbidity and sedimentation.

   i. In the 1980 dredging – there were monitoring stations on both sides of the channels. In the 1st and 2nd reef the currents run from North to South, beyond the 2nd reef going to the 3rd reef the currents are dominated by the Gulf Stream and the eddies generated from the Gulf Stream and move from south to North. In the 1980 dredging, with a cutterhead in the channel, with lower water quality standards than are in place today – no effect of the dredging was seen at any of the monitoring stations (north or south of the channel) as compared to baseline sites further from the channel. The 1980 report is available on the FTP site for review.

   ii. NMFS would like to review the 150-meter and determine if that is an appropriate for monitoring when we get to PED. The 150-m buffer is based on the four previous projects and those results. Other projects and monitoring for future projects will also feed into this process. NMFS would like to be part of the development of monitoring site locations for the pre, during and post phase.

This is where we are in Miami Harbor and NMFS will be involved extensively with that process and that process would be mimicked for Port Everglades. NMFS would also like to have monitoring sites with *A. cervicornis* present and include that information in the monitoring.

iii. Can the Entrance Channel dredging be completed during a time of year that will not expose the already stressed *Acropora* (stress associated with summer sun, still water and warm water) to turbidity and sedimentation? USACE recommended that NMFS include any window in the Biop Terms and Conditions that can then be incorporated into the Environmental Commitments section of the FEIS and the plans and specifications that the contractors would then bid against and be able to plan for. Previous Entrance channel dredging in 1980 was completed in 109 dredging days between 4 May and 27 December 1980. Weather, ship traffic and equipment will play huge role in how long it takes to complete this work. A window will increase dredging time since weather can drive the dredge inshore more often. NMFS may recommend a July – early September window, in which dredging would be prohibited or limited to specified locations away from coral, due to water temperature and still, calm water (high levels of UV light).

f. Review of the document – National Academy of Science will review Baseline reports (Reef, seagrass, mangroves, etc); DEIS. NAS review will begin after the scope is complete. The first phase will be baseline materials. Second phase will be the DEIS. An interim report on the science will be provided by the NAS. Lead coordinator for the NAS process is the Center of Expertise for Deep Draft Navigation (Mobile District). SAJ is coordinating with them and NAS.

g. Discussions of Miami Harbor pending surveys (summer/early fall 2008) with a consultation in the fall 2008. Miami is in PED. Port of Palm Beach is also pending ESA consultation.

h. Alternative 5 in the DEIS is the maximum impact. Cooperating agency staffs believe that they feel they can remove the flare in the entrance channel. USGC and pilots specifically document accidents, allisions and collisions in the Feasibility Study. The larger ships (post-panamax) ships have already been turned away from Port Everglades due to lack of entrance channel depth. Documentation of these requests has been provided to USACE by the pilots and the ports. Pilots requested a 1,000 ft wide entrance channel flare – the ship simulation documented a need for no more than an 800 ft wide flare. Discussions also included the ability to use tugs, etc. David Bernhart agreed with USACE analysis regarding speed needs entering Port Everglades – which is faster than a tug can catch the ship to bring them in under tug power. There is n way to reduce the flare beyond the 800ft width currently proposed when considering vessel safety as the primary consideration. If the 1,000 ft flare had been included in would have resulted in an additional 7.9 acres of reef impacts to the 2nd and 3rd reef.

i. Seagrass and mangrove mitigation discussion. Westlake Park construction of mitigation area to start in 200 – early mitigation as compared to impact proposed in 2012. 90% plans and specs being completed and getting ready to move forward with bidding to contractors which would allow construction to begin in 2009. Monitoring will be done by County to verify the success of mitigation efforts with reports to USACE/SFWMD/County.

Tasks/To Dos –

1. USACE will prepare a proposed draft protocol for using video as a baseline for *Acropora* surveys in large scale projects.

2. NMFS will review this protocol and make recommendations for change/accept the proposal for implementation (Audra/Margaret Miller/others). New protocol would be for four channels in Florida, five in Puerto Rico and two in the USVI. This may best be harbor/channel survey specific protocol. This would be technology based survey since humans in channels is a dangerous situation. Note: NMFS may recommend some in-water transects (by divers) outside of the channel in areas of potential indirect impact (from sedimentation and/or turbidity) that support hardbottom (i.e., areas that have the PCE for Acropora proposed critical habitat).

3. USACE will use DEIS, when released to the public, as the final item in the consultation initiation package. The DEIS will include a proposed action that USACE is consulting on and will include conservation/mitigation measures aimed at protected resources. Consultation will be based on what NMFS knows now and that proposed action.

   a. Breaks in rip rap bulkheads at TN to increase possible access for sawfish (also increased flushing for the mangroves).

   b. *Acropora* survey using video as the baseline in the PE&D phase of the project (2012 construction – 2009-2010 for PED assuming that there is WRDA 200 that would include Port Everglades – which may be a contingent authorization – however the report must be completed by the end of the calendar year. This would require FS and EIS to be completed by Dec 31, 2008. Not very likely).

   c. Monitoring sites for indirect effects from turbidity and sedimentation development of protocol and locations during PE&D phase.

   d. All blasting criteria used in Miami Harbor and lessons learned from Miami.

   e. NMFS-PRD can help write the mitigative measures with USACE for the DEIS under the cooperating agency agreement under CEQ NEPA regs.

4. NMFS will prepare a biological opinion (formal consultation) for the Port Everglades project.

    a. Will include final designated Critical Habitat in the Biop (expected to be final in Nov 2008, and Biop will likely be after the finalization of the CH).

    b. Survey is committed to – what does USACE/NMFS do if the *Acropora* is found during the survey during PED. If section 7 consultation is already complete, COE may need to reinitiate if colonies need to be re-located (since this would constitute take).

Attachments and Supplemental Information –

198 Monitoring Report – available on USACE FTP site – ftp://ftp.saj.usace.army.mil/pub/Public_Dissemination/Port_Everglades_Feasibility_Study/Documents/Previous%20Deeping%20Project%20Documents%20-%201980

Key West Report – 2004-2006 Dredging

ftp://ftp.saj.usace.army.mil/pub/Public_Dissemination/Port_Everglades_Feasibility_Study/Meetings/02-Feasibility%20Phase%20Meetings/2007/Sept%2025%20&%2026%20HEA%20meeting/Other%20studies/Final%20RIAM%20Report%20Key%20West%202004-2006%20Dredge.pdf

Key West Report – 2007 Dredging

ftp://ftp.saj.usace.army.mil/pub/Public_Dissemination/Port_Everglades_Feasibility_Study/Meetings/02-Feasibility%20Phase%20Meetings/2007/Sept%2025%20&%2026%20HEA%20meeting/Other%20studies/RHSM%20Report%202007.pdf

Terri has photos of the TN rip rap and the JUL rip rap if NMFS is interested – can email under separate cover

UNITED STATES DEPARTMENT OF COMMERCE
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MAR 26 2008 F/SER31:AL

Ms. Marie Burns
Environmental Branch Chief – Planning Division
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Ms. Burns:

The National Marine Fisheries Service (NMFS) Protected Resources Division (PRD) wishes to respond to numerous inquiries from your staff regarding the status of our biological opinion (BO) for the proposed Port Everglades dredging project in Broward County, Florida. As a cooperating agency for this project, we have reviewed and commented on the first version of the interim Draft Environmental Impact Statement (DEIS). Currently, the Corps of Engineers (COE) does not have an official proposed action for this project. In addition, we have not been provided with a draft mitigation plan. The proposed mitigation is part of the proposed action for the project and as such also needs to be considered for its effects on our species. It is quite possible that the scope of the proposed action may change depending on comments received from the cooperating agencies as well as comments received by the public once the DEIS is released for public comment.

We would like to reiterate the recommendations provided in our August 18, 2006, letter, a survey designed specifically to identify and quantify the presence and density of federally-listed acroporid coral colonies that may be present within or nearby the project area. We do not believe the information the COE has provided is sufficient to allow for an adequate review of the project's effects on these species. An analysis of the project's effects on listed corals based on the currently provided information would be arbitrary.

We are advising the COE that staghorn coral colonies have been documented approximately 3,500 feet south of the entrance channel to Port Everglades at JUL6, which is a permanent annual monitoring station for Broward County. Broward County Environmental Protection Department personnel have reported an increase in density of staghorn coral colonies at JUL6. This is supported by their data from 2004 and 2005, which showed an increase in density from 14 colonies per square meter in 2004 to 38 colonies per square meter in 2005. Examination of high resolution bathymetry for Broward County around Port Everglades indicates that the reef substrate that is characteristic of JUL6 appears to extend northward into the area of impact for the proposed project. Therefore, without a proper survey, it is reasonable to assume that staghorn coral colonies may occur closer than 3,500 feet from the entrance channel and may be present in close enough proximity to be adversely affected by turbidity and sedimentation from proposed dredging of the outer entrance channel.

In addition, NMFS has advised the COE (by e-mail dated February 6, 2008) that the extension of the Port Everglades outer entrance channel may affect proposed critical habitat for elkhorn and staghorn coral. We believe the primary constituent element (PCE) essential to the conservation of these species may be adversely affected by the proposed project. The proposed rule (50 CFR Parts 223 and 226) defines the PCE as "consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover...in water depths from mean high water to 30 meters." In Florida, Acropora critical habitat is proposed from the Dry Tortugas north to Palm Beach County, and includes substrate of suitable quality and availability in Broward County. We wish to reiterate that this project may affect proposed critical habitat for elkhorn and staghorn coral.

Based on the preceding, it would be premature for us to complete our draft biological opinion at this time. I propose you and I and our respective staffs meet at your earliest convenience to discuss moving forward on this high-profile project. If you have any questions, please contact me at (727) 551-5767, or by e-mail at David.Bernhart@noaa.gov.

Sincerely,

David M. Bernhart
Assistant Regional Administrator
for Protected Resources

cc:

F\SER47 - Jocelyn Karazsia
Chantal Collier, FDEP
Dr. Vladimir Kosmynin, FDEP
Erin McDevitt, FWC
Lisa Gregg, FWC
Ken Banks, Broward County EPD
Terri Jordan, COE Planning Division

Ref. F/SER/2002/00626
File: 1514-22.f.1.Fl

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

Planning Division
Environmental Branch

OCT 1 8 2006

Mr. David Bernhart
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
263 13th Avenue South
St. Petersburg, Florida 33701

Dear Mr. Bernhart:

The U.S. Army Corps of Engineers (Corps), Jacksonville District is currently conducting a feasibility study to assess Federal interest in navigation improvements throughout Port Everglades. This letter is in response to your letter dated August 18, 2006. The letter references the recently completed Port Everglades Reef Mapping and Assessment Preliminary Draft, and finds that in National Marine Fisheries Service's (NMFS) opinion "the study is flawed. It does not provide the Service with the best scientifically or commercial data available or which can be obtained for an adequate review of the effects that the action may have upon listed species..." Initiation of consultation for this action was by letter dated March 28, 2002.

The Corps' survey teams spent a total of 144 man hours in the water on the impact and control areas, as well as collected and reviewed more than 50 hours of video of the impact and control areas. The total impact area surveyed is 54.6 acres (the direct project footprint and an area to be assessed for possible indirect impacts). Other survey efforts for the project area include towed video and diver transect surveys in 2001 as part of the baseline report development (USACE, 2001); an October 2002 resource assessment conducted by a group of resource agency staff (including Michael Johnson of NMFS) and ongoing research efforts by scientists from Broward County DPEP and NOVA University (Broward County, 2001 and Gillem *et al.*, 2004). Given the amount of time spent in the water by all parties, the amount of video footage collected and analyzed, after discussions with Dr. Precht, the research team, and other Acroporid coral experts, the Corps believes that if a stand of either Acroporid coral, greater in age than 1-2 years (the age at which they become visible to the naked human eye (NMFS, 2005)) were located in the impact zone or the control areas, they would have been noted and recorded. To date, neither species have been recorded in or near the project area.

The NMFS recommends "An active and quantitative survey designed specifically to identify and quantify the presence and abundance of elkhorn and staghorn coral should be conducted for the proposed impact areas and control sites." Based on the surveys cited above, the Corps believes that there is sufficient data available to make a determination. It is possible that all of this combined survey effort has missed some small isolated acroporid corals. If such small isolated acroporid corals were present, the affect would be classified as insignificant or discountable, thus the basis of our June 2005 finding of "may affect, but not likely to adversely affect" is still valid.

NMFS cites the report's introduction that states the area was once "dominated" by Elkhorn coral as justification for the survey. The preceding sentence states "The reef communities that presently occur off Broward County cover drowned reefs formed during the Holocene". This was a citation from Lighty et al, 1978 which states "Radiocarbon dates obtained for the *Acropora palmata* facies indicate that the reef is Holocene in age, but has had no significant reef-framework accumulation for the past 6,000 years." The relic drowned reef at the mouth of the entrance channel at Port Everglades was built predominantly by *A. palmata* more than 6,000 years ago. Dr. Bill Precht has confirmed that neither *A.palmata*, nor *A.cervicornis* have been dominant on the reefs off of Broward County for about 6,000 years. The additional reference in the NMFS letter to documentation of *A.cervicornis* on the third reef dates back to a 1973 Goldberg reef survey off of Boca Raton, which is 22 miles north of the project area. However, a more recent study conducted by Gilliam *et al.* in 2004 throughout Broward County (with one of his survey areas – JUL #8 located 2,950 feet south of the proposed impact area) found no *A.cervicornis* on the third reef.

We understand the Service's concerns, and believe that we have addressed them. As part of the minimization and avoidance of impacts for the project, the Corps commits to survey for and relocate any corals larger than 12 inches in size (30.48cm) prior to dredging the entrance channel extension. Should Acroporid species be found during this relocation effort, the Corps commits to relocating any *A.palmata* and *A.cervicornis* identified during the relocation surveys, even if they are less than 12 inches (30.48 cm) in size and reinitiating consultation with NMFS under Section 7 of the Endangered Species Act.

If you have any questions, please contact Ms. Terri Jordan at 904-232-1817 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

Marie G. Burns
Chief, Environmental Branch

Enclosure

Memo for the Record - Effects Determination – Acropora Palmata
For ESA consultation with NMFS
Per request from Audra Livergood, NMFS-PRD – Miami, FL

The Corps has previously sent an affect determination for *Acropora palmata* and *A.cervicornis* under the ESA via an email to Mr. Juan Levesque of NMFS dated June 23, 2005. A summary of that email and a determination of direct impacts are included below.

Indirect Effect –
From June 2005 email - "Juan - after reviewing the "Broward County Shore Protection Project Geographic Information System database" that compiled all available data on offshore resources in Broward county (a copy of this 9-cd notebook was provided to NMFS as part of the BCSPP in 2001), the Corps has determined that the nearest *Acropora cervicornis* patch is located 21,277 feet (4.02 statue miles) north of the north jetty of the Port Everglades entrance channel, and the nearest *Acropora palmata* patch is located 46,405 feet (8.79 statue miles) north of the north jetty of the Port Everglades entrance channel. The Corps has photo documentation of a small patch of A. cervicornis to the south of the entrance channel within the boundaries of the John U. Lloyd State Park approximately 2,000 feet south of the south jetty that was not mapped by Broward County (from what we can determine). We are working to get a more detailed assessment of where this patch is located. However, since the current is this area is directly influenced by the Gulf Stream, it is unlikely that any sediment in the water column would move south of the channel, it is more likely it will move north under the influence of the South to North current. Also - due to the distance from the channel to the northerly mapped stands, it is also unlikely there will be any effect from the deepening project in the entrance channel from turbidity or sedimentation.

The Corps determines that the Port Everglades Feasibility Study, may effect, but is not likely to adversely affect either *Acropora cervicornis* or *Acropora palmata*, both currently proposed as threatened under the Endangered Species Act of 1973 and ask that NMFS concur with this determination in a conference opinion.

Direct Effect –
Per the recently finalized "Port Everglades Reef Report" completed on 10-10-2006 and provided to NMFS and other resource agency staff on 10-13-2006. The Corps' survey teams spent a total of 144 man hours in the water on the impact and control areas, as well as collected and reviewed more than 50 hours of video of the impact and control areas. The total impact area surveyed is 54.6 acres (the direct project footprint and an area to be assessed for possible indirect impacts). Other survey efforts for the project area include towed video and diver transect surveys in 2001 as part of the baseline report development (USACE, 2001); an October 2002 resource assessment conducted by a group of resource agency staff (including Michael Johnson of NMFS) and ongoing research efforts by scientists from Broward County DPEP and NOVA University (Broward County, 2001 and Gilliam *et al.*, 2004). Given the amount of time spent in the water by all parties, the amount of video footage collected and analyzed, after discussions with Acroporid coral experts, the Corps believes that if a stand of either Acroporid coral, greater in age than 1-2 years (the age at which they become visible to the naked human eye (NMFS, 2005))

were located in the impact zone or even the control areas, they would have been noted and recorded. To date, neither species have been recorded in or near the project area.

However, it is possible that all of this combined survey effort has missed some small isolated Acroporid corals. If such small isolated Acroporid corals were present, the affect would be classified as insignificant or discountable, thus the basis of our June 2005 finding of "may affect, but not likely to adversely affect" would not change.

During discussions with NMFS-PRD, the Corps reiterated a commitment prior to dredging the entrance channel extension, to survey for and relocate any corals larger than 12 inches in size (30.48cm). During this survey, the Corps will commit to relocating any *A.palmata* and *A.cervicornis* identified during the relocation surveys, even if they are less than 12 in (30.48 cm) in size.

Literature cited

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Planning Division
Environmental Branch

Mr. David Bernhart
National Marine Fisheries Service
Southeast Regional Office
Protected Species Resources Division
263 13th Avenue South
St. Petersburg, Florida 33701

Dear Mr. Bernhart:

The U.S. Army Corps of Engineers (Corps), Jacksonville District is currently conducting a feasibility study to assess Federal interest in navigation improvements throughout Port Everglades. This letter is in response to your letter dated August 18, 2006. The letter references the recently completed Port Everglades Reef Mapping and Assessment Preliminary Draft, and finds that in NMFS opinion "the study is flawed. It does not provide the Service with the best scientifically or commercial data available or which can be obtained for an adequate review of the effects that the action may have upon listed species…" Initiation of consultation for this action was by letter dated March 28, 2002.

The Corps' survey teams spent a total of 144 man hours in the water on the impact and control areas, as well as collected and reviewed more than 50 hours of video of the impact and control areas. The total impact area surveyed is 54.6 acres (the direct project footprint and an area to be assessed for possible indirect impacts). Other survey efforts for the project area include towed video and diver transect surveys in 2001 as part of the baseline report development (USACE, 2001); an October 2002 resource assessment conducted by a group of resource agency staff (including Michael Johnson of NMFS) and ongoing research efforts by scientists from Broward County DPEP and NOVA University (Broward County, 2001 and Gillem *et al.*, 2004). Given the amount of time spent in the water by all parties, the amount of video footage collected and analyzed, after discussions with Dr. Precht, the research team, and other Acroporid coral experts, the Corps believes that if a stand of either Acroporid coral, greater in age than 1-2 years (the age at which they become visible to the naked human eye (NMFS, 2005)) were located in the impact zone or the control areas, they would have been noted and recorded. To date, neither species have been recorded in or near the project area.

The NMFS recommends "An active and quantitative survey designed specifically to identify and quantify the presence and abundance of elkhorn and staghorn coral should be conducted for the proposed impact areas and control sites." Based on the surveys cited above, the Corps believes that there is sufficient data available to make a determination. It is possible that all of this combined survey effort has missed some small isolated acroporid corals. If such small isolated acroporid corals were present, the affect would be classified as insignificant or discountable, thus the basis of our June 2005 finding of "may affect, but not likely to adversely affect" is still valid.

NMFS cites the report's introduction that states the area was once "dominated" by Elkhorn coral as justification for the survey. The preceding sentence states "The reef communities that presently occur off Broward County cover drowned reefs formed during the Holocene". This was a citation from Lighty et al, 1978 which states "Radiocarbon dates obtained for the *Acropora palmata* facies indicate that the reef is Holocene in age, but has had no significant reef-framework accumulation for the past 6,000 years." The relic drowned reef at the mouth of the entrance channel at Port Everglades was built predominantly by *A. palmata* more than 6,000 years ago. Dr. Bill Precht has confirmed that neither *A.palmata*, nor *A.cervicornis* have been dominant on the reefs off of Broward County for about 6,000 years. The additional reference in the NMFS letter to documentation of *A.cervicornis* on the third reef dates back to a 1973 Goldberg reef survey off of Boca Raton, which is 22 miles north of the project area. However, a more recent study conducted by Gilliam *et al.* in 2004 throughout Broward County (with one of his survey areas - JUL #8 located 2,950 feet south of the proposed impact area) found no *A.cervicornis* on the third reef.

We understand the Services concerns, and believe that we have addressed them. As part of the minimization and avoidance of impacts for the project, the Corps commitments to survey for and relocate any corals larger than 12 inches in size (30.48cm) prior to dredging the entrance channel extension. Should Acroporid species be found during this relocation effort, the Corps commits to relocating any

A.palmata and *A.cervicornis* identified during the relocation surveys, even if they are less than 12 inches (30.48 cm) in size and reinitiating consultation with NMFS under Section 7 of the ESA.

If you have any questions, please contact Ms. Terri Jordan at 904-232-1817 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

Marie R. Burns
Chief, Environmental Branch

Enclosure

Jordan/CESAJ-PD-EC/1817/
Dugger/CESAJ-PD-EC
Ross/CESAJ-DP-C
Burns/CESAJ-PD-E

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Section 7 Consultation Package –

US Fish and Wildlife Service

March 25, 2002

Planning Division
Environmental Branch

Mr. James J. Slack
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, Florida 32960-3559

Dear Mr. Slack:

The U.S. Army Corps of Engineers (Corps), Jacksonville District proposes to conduct a feasibility study to assess Federal interest in navigation improvements throughout Port Everglades. An evaluation of benefits, costs, and environmental impacts determines Federal interest. This Feasibility Study was authorized by a resolution of the House Committee on Transportation dated May 9, 1996.

The Recommended Plan's main elements include: widening and deepening (to -53/-50 feet) the Outer Entrance Channel, deepening the Inner Entrance Channel and Main Turning Basin to -50 feet, widening and deepening (to -47 feet) the Southport Access Channel, widening and deepening (to -32 feet) the Dania Cutoff Canal, constructing a Turning Basin at the intersection of the Dania Cutoff Canal and the Southport Access Channel at -32 feet, deepening a portion of the South Turning Basin to -44 feet, and widening and deepening (to -47 feet) the Turning Notch. Other significant construction items include relocation of the U.S. Coast Guard Basin (USCG) easterly within essentially USCG property, port facility construction, and environmental mitigation.

The Corps originally initiated consultation on this project on October 22, 1998 by sending a Biological Assessment to your office with a finding that the proposed project may affect, but was not likely to adversely affect manatees within the action area. On December 21, 1998, your office concurred with our finding. A copy of this original concurrence is included with this new assessment for your information.

The proposed project has changed significantly since this original consultation was concluded, and as a result, the Corps requests re-initiation of consultation under Section 7 of the ESA. Enclosed please find the Corps' biological assessment of the effects of the project as currently proposed on listed species and marine mammals in the action area and a copy of the draft EIS prepared for this proposed project.

After preparing this Biological Assessment of the impacts of the proposed project, the Corps has determined that the proposed project may affect, but is not likely to adversely affect the endangered Florida manatee (*Trichecus manatus*) found in the action area and we request that you concur with this finding.

If you have any questions, please contact Ms. Terri Jordan at 904-899-5195 or terri.l.jordan@saj02.usace.army.mil.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Copy furnished w/encl:

Dr. Robbin Trindell, Florida Fish and Wildlife Conservation Commission, Office of Environmental Services, Protected Species Management, 620 South Meridian Street, Tallahassee, Florida 32399-6000

Jordan/CESAJ-PD-EA/3453/
McAdams/CESAJ-PD-EA
Dugger/CESAJ-PD-E
Schwictenberg/CESAJ-DP-C
Strain/CESAJ-PD-P
Duck/CESAJ-PD

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BIOLOGICAL ASSESSMENT
PORT EVERGLADES NAVIGATION PROJECT
BROWARD COUNTY, FLORIDA

Description of the Proposed Action

The U.S. Army Corps of Engineers (Corps) proposes to expand and deepen Port Everglades Harbor. A detailed description of the proposed project and all alternatives considered under the Feasibility Study are evaluated in the Draft Environmental Impact Statement enclosed with this Biological Assessment. Broward County requested that the Corps study the feasibility of widening and deepening most of the major channels and basins within Port Everglades. Four major improvement goals were identified. 1) Improve transit in the Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB) and Southport Access Channel (SAC) to accommodate liquid bulk, cruise, and container vessels; 2) Develop the DCC (DCC) to accommodate mid-size container vessels; 3) Deepen the North Turning Basin to accommodate Panamax (and larger) size container ships; and 4) Improve turning and berthing in the Turning Notch (TN).

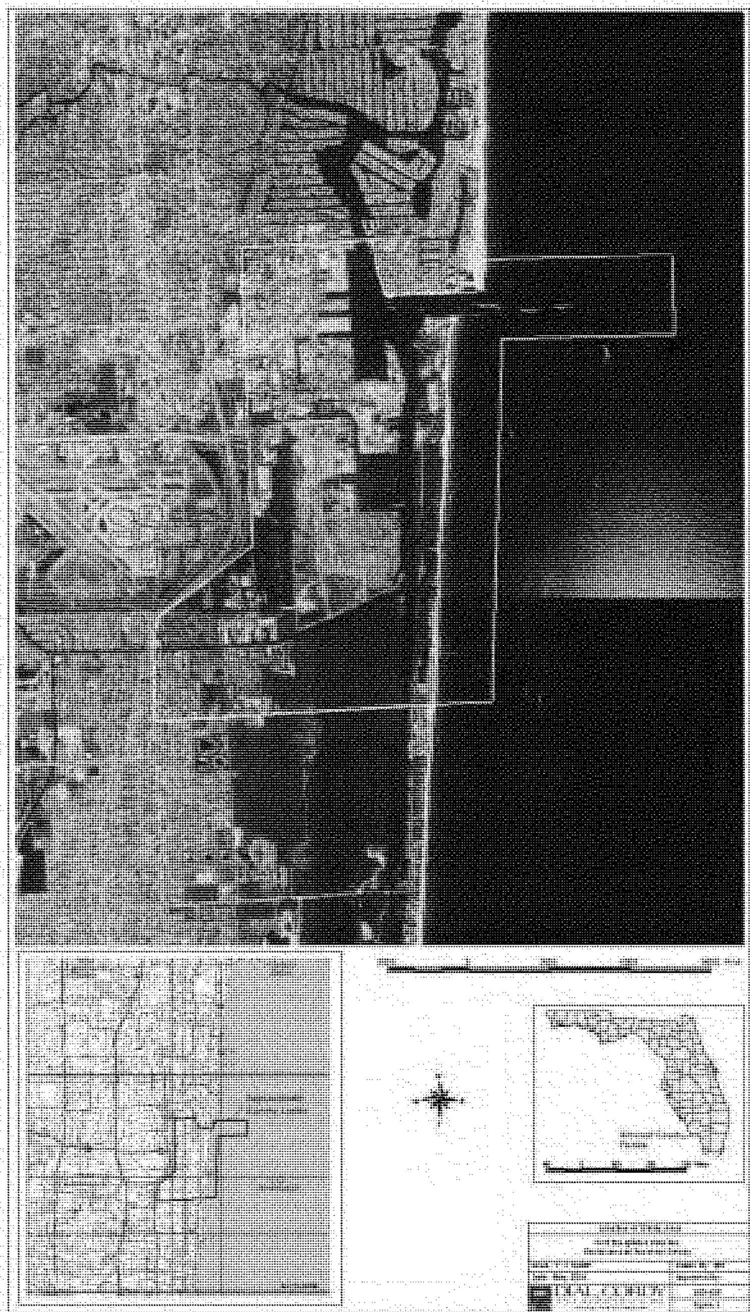
The purpose of the proposed action is to provide increased safety, efficiency and lower costs for future port navigation and utilization, while protecting the environment. The proposed action resulted from a comprehensive analysis of all the existing and future commercial vessel transit needs within the port. This economic analysis has shown that improvements to most of the major Federal and non-Federal channels and basins are required to achieve efficient transit of the existing fleet, and to accommodate the future fleet. Substantial liquid bulk cargo cost savings can be achieved by deepening the OEC, IEC, and MTB. Widening of the OEC flare will allow safer transit for all the larger commercial vessels that experience sometimes troublesome cross currents at the channel entrance. Removal of the Widener Shoal and widening of the SAC allows for more efficient and safer transits of containerized cargo vessels past the Knuckles restriction where new generation cruise vessels are expected to be berthed. Lengthening and deepening of the TN will provide turning possibilities for larger vessels and will provide critical berthing for containerized cargo vessels. Deepening of the STB will allow for more efficient use Berths 16-18 by allowing Panamax vessel calls. Finally, widening and deepening of the DCC (in addition to a turning basin located adjacent to the SAC) will allow for relocation of smaller and midsize container, roll on/roll off (ro/ro) vessels, and general cargo traffic, thereby reducing congestion in the areas serviced by larger vessels.

The Corps expects the construction to be performed using a variety of methods including blasting and dredging with a cutterhead, clamshell or other type of dredge. Any blasting that will occur within the project will be confined blasting. Confined blasting is defined as a blast where the explosives had been placed in a hole bored into the rock substrate and capped with 3-4 feet of crushed rock known as "stemming". Stemming forces the explosive blast downward into the rock instead of allowing the blast to expand into the water column.

Action Area

The Port Everglades Harbor is a major seaport located on the southeast coast of Florida. It is located within the cities of Hollywood, Dania Beach and Fort Lauderdale, with immediate access to the Atlantic Ocean. The entrance of the Port is approximately 27 nautical miles north of Miami Harbor, Florida and 301 nautical miles south of Jacksonville Harbor, Florida. Figure 1 shows the location of the project site.

Figure 1 - Location of Project



The existing Port Everglades Federal Navigation Project provides for an Outer Entrance Channel (OEC) that is 45 feet deep and 500 feet wide, an Inner Entrance Channel (IEC) that is 450 feet wide and 42 foot deep, a Main Turning Basin (MTB) that is 42 feet deep, a North Turning Basin (NTB) that is 31 feet deep, a South Turning Basin that is (STB) 31 to 36 feet deep, a Southport Access Channel (SAC) that is 390-400 feet wide and 42 feet deep, and a Turning Notch (TN) that is 42 feet deep. To the east of the port is a barrier island that contains a U.S. Navy facility, a NOVA Southeastern University facility, a U.S. Coast Guard facility, and John U. Lloyd State Recreation Area and its adjacent beaches. South of the port's DCC is the Westlake Park area. West of the port is Federal Highway which is flanked by the Fort Lauderdale/Hollywood International Airport. North of the port is a mixture of small craft waterways and commercial and residential development.

Protected Species Included in this Assessment

Of the listed and protected species under FWS jurisdiction occurring in the action area, the Corps believes that only the Florida manatee (*Trichecus manatus*) may be affected by the implementation of the Navigation Project. Although there is designated critical habitat for the Florida manatee throughout south Florida, the action area is not located within this designated habitat (50 CFR 17.95).

The Federal government has recognized the threats to the continued existence of the Florida manatee for more than 30 years. The West Indian manatee was first listed as an endangered species in 1967 under the Endangered Species Preservation Act of 1966 (16 U.S.C. 668aa(c)) (32 FR 48:4001). The Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa(c)) continued to recognize the West Indian manatee as an endangered species (35 FR 16047), and the West Indian manatee was also among the original species listed as endangered pursuant to the Endangered Species Act of 1973. Critical habitat was designated for the manatee in 1976. The justification for listing as endangered included impacts to the population from harvesting for flesh, oil, and skins as well as for sport, loss of coastal feeding grounds from siltation, and the volume of injuries and deaths resulting from collisions with the keels and propellers of powerboats. Manatees are also protected under the provisions of the Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 *et seq.*) and have been protected by Florida law since 1892. Florida provided further protection in 1978 by passing the Florida Marine Sanctuary Act designating the state as a manatee sanctuary and providing signage and speed zones in Florida's waterways.

Species and suitable habitat descriptions

Status and Distribution of the Florida manatee

All manatees belong to the Order Sirenia. The living sirenians consist of one species of dugong and three species of manatee. A fifth species, the Steller's sea cow, was hunted to extinction by 1768. The Greek name for this order is derived from the sirens of Greek mythology. Sirens were female, partly human creatures that lured ships onto the rocks by their mesmerizing songs.

All living sirenians are found in warm tropical and subtropical waters. The West Indian manatee was once abundant throughout the tropical and subtropical western North and South Atlantic and Caribbean waters. However, the manatee's numbers have been greatly reduced. Today the West Indian manatee is listed as an endangered species throughout its range.

Habits

Florida manatees are herbivores that feed opportunistically on a wide variety of submerged, floating and emergent vegetation. Shallow grass beds with ready access to deep channels are the preferred feeding areas in coastal and riverine habitats. Bengtson (1983) estimated that the annual mean consumption rate for manatees feeding in the upper St. John's Ricer at 4% to 9% of their body weight per day depending on season. A complete review of manatee biology is included in the manatee section of the South Florida Multi-species Recovery Plan (FWS, 1999) and will not be repeated here.

Distribution

The manatee occurs throughout the southeastern United States. The only year-round populations of manatees occur throughout the coastal and inland waterways of peninsular Florida and Georgia (Hartman 1974). During the summer months, manatees may range as far north along the East Coast of the U.S. as Rhode Island, west to Texas, and, rarely, east to the Bahamas, FWS 1996, Lefebvre *et al.* 1989). There are reports of occasional manatee sightings from Louisiana, southeastern Texas, and the Rio Grande River mouth (Gunter 1941, Lowery 1974).

In Florida, manatees are commonly found from the Georgia/Florida border south to Biscayne Bay on the east coast and from Wakulla River south to Cape Sable on the west coast (Hartman 1974, Powell and Rathbun 1984) (Figure 1). Manatees are also found throughout the waterways in the Everglades and in the Florida Keys. Although temperatures are suitable for manatees in the Florida Keys, the low number of manatees has been attributed to the lack of fresh water (Beeler and O'Shea 1988). Manatees also occur in Lake Okeechobee.

In warmer months (April to November), the distribution of manatees along the east coast of Florida tends to be greater around the St. Johns River, the Banana and Indian rivers to Jupiter Inlet, and Biscayne Bay. On the west coast of Florida, larger numbers of manatees are found at the Suwannee, Crystal and Homosassa rivers, Tampa Bay, Charlotte Harbor/Matlacha Pass/San Carlos Bay area, the Caloosahatchee River and Estero Bay area, the Ten Thousand Islands, and the inland waterways of the Everglades. On the west coast, manatee's winter at Crystal River, Homosassa Springs, and other warm mineral springs (Powell and Rathbun 1984, Rathbun *et al.* 1990). In the winter, higher numbers of manatees are seen on the east coast at the natural warm waters of Blue Spring and near man-made warm water sources on or near the Indian River Lagoon, at Titusville, Vero Beach, Ft. Pierce, Riviera Beach, Port Everglades, Ft. Lauderdale, and throughout Biscayne Bay and nearby rivers and canals (FWS 1996). They also aggregate near industrial warm water outflows in Tampa Bay, the warmer waters of the Caloosahatchee and Orange rivers (from the Ft. Myers power plant), and in inland waters of the Everglades and Ten Thousand Islands.

Habitat preferences

The Florida manatees inhabit rivers, bays, canals, estuaries, and coastal areas rich in seagrass and other vegetation. They can live in fresh, saline (salt), and brackish water. They move freely between salinity extremes. Manatee may be found in any waterway over 3.25 ft. (1 m) deep and connected to the coast. They prefer water above 70 degrees F (21 degrees C). Florida manatees rarely venture into deep ocean waters. However, there are reports of manatees in locations as far offshore as the Dry Tortugas Islands, approximately 50 mi. (81 km) west of Key West, Florida. The patchy distribution of manatees throughout all their ranges is due to the distribution of suitable habitat: plentiful aquatic plants and a freshwater source.

Migration
Florida manatees move into warmer waters when the water temperature drops below about 68 degrees F (20 degrees C). The geographic distribution of manatees within Florida has changed since the 1950s and 60s (Lefebvre *et al.* 1989) and prominent shifts in seasonal distribution are also evident. Before man introduced warm effluents from power plants to the natural environment in the early 1950s, the winter range of the manatee in Florida was most likely limited on its northern bounds by the Sebastian River on the east coast and Charlotte Harbor on the west coast (Moore 1951). Since that time, manatees altered their normal migration patterns and appreciable numbers of manatees began aggregating at new sites. As new power plants became operational, more and more manatees began taking advantage of the sites by traveling great distances just to bask in the warm waters. Among the most important of the artificial warm-water discharges are the Florida Power and Light Company's power plants at Cape Canaveral, Fort Lauderdale, Port Everglades, Riviera Beach, and Fort Myers, as well as the Tampa Electric Company's Apollo Beach power plant in Tampa Bay, Florida. These artificially heated sources have allowed manatees to remain north of their historic wintering grounds. They may have replaced natural warm water springs destroyed or made inaccessible through human development. More than 200 manatees have been reported at some power plants during cold weather. The introduction of power plants and paper mills in northern Florida, southern Georgia, Louisiana, and Texas has given manatees the opportunity to expand their winter range to areas not previously frequented (Hartman 1979). However, warm water industrial discharges alone are not suitable alternatives to the natural warm water refugia provided by natural springs because they usually lack the vegetation necessary to sustain the manatees.

Status of the species
Determining exact population estimates or trends is difficult for this species. The best indicator of population trends is derived from mortality data and aerial surveys (Ackerman *et al.* 1992, Ackerman *et al.* 1995, Lefebvre *et al.* 1995). Aerial surveys conducted for more than 20 years have shown an increase in numbers, but this information is not an accurate account of trends since data has been obtained using different survey methods. O'shea (1988) found no firm evidence of a decrease or increase between the 1970s and 1980s, even though aerial survey counts have increased. Increases in the number of recovered dead manatees have been interpreted as evidence of increasing mortality rates (Ackerman *et al*. 1992, Ackerman *et al.* 1995). Because manatees have low reproductive rates, these increases in mortality may lead to a decline in the population (O'shea *et al.* 1988, 1992).

Although there are no accurate estimates of manatee population size, the Florida Department of Environmental Protection's (DEP) 1996 aerial surveys conducted from February 18-19, determined there were at least 2,639 manatees in Florida's waters. DEP conducted two surveys in 1997. The January survey determined that 2,229 manatees were present in Florida's waters:

900 on the east coast and 1,329 manatees on the west coast. The February survey determined that 1,709 manatees were present in Florida's waters: 791 manatees on the east coast and 918 on the west coast. Surveys conducted by DEP in 1996 and 1997 determined that numbers of manatees on the east coast and west coasts of Florida are almost equal (Rathbun *et al.* 1992). These estimates represent the minimum number of manatees in Florida waters and may not represent the total population size. As of the January 2001 census, the minimum Florida manatee population was 3,276 (FWRI 2002).

Mortality

Despite the lack of accurate estimates of the manatee population size, human activities have significantly affected manatees by eliminating or modifying suitable habitat, altering migratory access routes, increasing mortality, and decreasing abundance, all of which in turn, can affect manatee reproduction, recruitment, distribution, and behavior. To understand manatee mortality trends in Florida, Ackerman *et al.* (1995) evaluated the number of recovered carcasses between 1974 and 1992 and categorized the causes of death. During that time interval, the number of manatees killed in collisions with watercraft increased each year by 9.3 percent. The number of manatees killed in collisions with watercraft each year correlated with the total number of pleasure and commercial watercraft registered in Florida (Ackerman *et al.* 1995). Other human-related threats include manatee death or injury from flood-control structures and navigational locks, entanglement in fishing line, entrapment in culverts, and poaching. These other threats accounted for 162 known mortalities between 1974 and 1993 (FRMI 2002a). Deaths from flood control structures and other human-related deaths did not change significantly but deaths due to these categories decreased more than deaths from other causes.

Table #2 – Statewide manatee mortalities – FRMI – Marine Mammal Pathology Lab database

Year	Watercraft	Flood Gate/ Canal Lock	Other Human	Perinatal	Cold Stress	Natural	Undetermined	Unrecovered	Total
1974	3	0	2	0	0	0	2	0	7
1975	6	1	1	7	0	1	10	3	29
1976	10	4	0	14	0	2	22	10	62
1977	13	6	5	9	0	1	64	16	114
1978	21	9	1	10	0	3	34	6	84
1979	24	8	9	9	0	4	18	5	77
1980	16	8	2	13	0	5	15	4	63
1981	24	2	4	13	0	9	62	2	116
1982	20	3	1	14	0	41	29	6	114
1983	15	7	5	18	0	6	28	2	81
1984	34	3	1	25	0	24	40	1	128
1985	33	3	3	23	0	19	32	6	119
1986	33	3	1	27	12	1	39	6	122
1987	39	5	2	30	6	10	22	0	114
1988	43	7	4	30	9	15	23	2	133
1989	50	3	5	38	14	18	39	1	168
1990	47	3	4	44	46	21	40	1	206
1991	53	9	6	53	1	13	39	0	174
1992	38	5	6	48	0	20	45	1	163
1993	35	5	6	39	2	22	34	2	145
1994	49	16	5	46	4	33	37	3	193
1995	42	8	5	56	0	35	53	2	201
1996	60	10	0	61	17	101	154	12	415
1997	54	8	8	61	4	42	61	4	242
1998	66	9	6	53	9	12	72	4	231
1999	82	15	8	53	5	37	69	0	269
2000	78	8	8	58	14	37	62	8	273
2001	81	1	7	61	32	33	108	2	325

Of interest is the increase in the number of perinatal deaths. The frequency of perinatal deaths (stillborn and newborn calves) has been consistently high over the past 5 years. This estimate may not be a true representation of the actual number of perinatal deaths that occur because the carcasses of these young animals may not be recovered. The cause of the increase in perinatal deaths is uncertain, but may result from a combination of factors that includes pollution, disease, or environmental change (Marine Mammal Commission 1992). It may also result from the increase in collisions between manatees and watercraft because some newborn calves may die when their mothers are killed or seriously injured by boat collisions, when they become separated from their mothers while dodging boat traffic, or when stress from vessel noise or traffic induces premature births (Marine Mammal Commission 1992). As a result of the high perinatal death rate, there are fewer young age classes present in the population.

Of the 1,907 manatee carcasses that have been recovered in Florida between 1989 and 1997, (DEP 1998) nearly half were female. The reduction of mature females places an additional burden and pressure on younger, less-experienced females to be the foundation for population growth. Younger females may be more apt to abandon their calves and less successful in calf rearing (Marine Technical Advisory Council 1994). A loss of mature, experienced males may also reduce the likelihood of successful mating. The greatest present threat to manatees is the high rate of manatee mortalities caused by watercraft collisions. O'Shea *et al.* (1985) recognized the dramatic increase in the rate of boat use in manatee habitat and, consequently, the increase in the potential of boat-related manatee injury or death. Between 1986 and 1992, watercraft collisions accounted for 37.3 percent of all manatee deaths, where the cause of death could be determined (Ackerman *et al.* 1995). The significance of manatee mortalities related to watercraft appears to be the result of dramatic increases in vessel traffic. Ackerman *et al.* (1995) showed a strong correlation between the increase in recorded manatee mortality and increasing boat registrations. In 1960, there were approximately 100,000 registered boats in Florida; by 1990, there were more than 700,000 registered vessels in Florida (Marine Mammal Commission 1992, Wright *et al.* 1995). Approximately 97 percent of these boats are registered for recreational use. The most abundant number of registered boats is in the 16-foot to 26-foot size class. Between 1974 and 1997, there were 3,270 known manatee mortalities in Florida. Of these, 749 were watercraft-related. Since 1974, an average of 31 manatees have died from watercraft-related injuries each year; between 1983 and 1993, manatee mortalities resulting from collisions with watercraft reached record levels (DEP 1994). Approximately twice as many manatees died from impacts suffered during collisions with watercraft than from propeller cuts; this has been a consistent trend over the last several years. Medium or large-sized boats cause most lethal propeller wounds, while impact injuries are caused by fast, small to medium-sized boats (Wright *et al.* 1992). Watercraft-related mortalities were most significant in the southwest and northeast regions of Florida; deaths from watercraft increased from 11 to 25 percent in southwestern Florida. In all of the counties that had high watercraft-related manatee deaths, the number of watercraft and the seasonal abundance of manatees were high (Ackerman *et al.* 1995).

Action area status information
Historical records regarding manatees in Broward County are sparse. Manatees are mentioned in documents that are dated as early as the mid 1800's and early 1900's (O'Shea 1988). Moore (1951) references observations told to him of common manatee use of the New River. It is unknown if these early accounts of manatees were associated with the Lauderdale Power Plant which began operations in 1926 (Mezich 2001). Prior to the Broward county power plants, Dade County may have been important historically to wintering manatees. Moore (1951) also notes the importance of the Miami River, including the 1943 anecdotal observation of more than 100 manatees killed during the deepening of the Miami River Channel and his 1956 reference of 195 manatees aggregating at the Miami power plant discharge (Mezich 2001). Additionally, the rivers, creeks and canals that open into Northern Biscayne Bay were locations noted for their manatee abundance.

Power plant usage as warm water refuge
Hartmann (1974) reported that an aggregation of as many as 30 manatees used the lower reaches of Port Everglades power plant's discharge canal during the early 1970's. The first organized aerial counts occurred in 1976 when the U.S. Fish and Wildlife Service funded them (Irvine and Campbell 1978). During the first survey on January 30, 1976, 78 manatees including 10 calves were counted in Broward County, all but two located at a power plant (Irvine and Campbell

1978). Since 1977, Florida Power and Light (FPL) has continued winter aerial surveys of at all of their coastal power plants. The increasing numbers of manatees counted at the Port Everglades plant during the early and mid 1970'a may have been a result of two factors. First, as noted by Rose and McCutcheon (1980) the Miami River Power plant closed in 1973, where Moore (1956) estimated as many as 195 manatees aggregated during the winter. Secondly, during the same time frame the FPL-Lauderdale plant was beginning to operate less consistently, which may have discouraged manatees from this site.

Data prior to 1993 corresponds with later information that manatees have favored the Port Everglades facility over the Lauderdale plant. The USGS-Sirenia Project radio tagged 71 manatees and monitored their movements over a 12-year period from 1986 to 1998. Seventeen of these individuals visited the Port Everglades facility as opposed to 5 visiting the Lauderdale facility. Additionally, in 1986 a total of 124 individual manatees had been cataloged at Port Everglades by photographic records of distinctive scar patterns (Reid and Rathburn 1995).

Mezich (2001) believes that the manatee preference for the Port Everglades may be changing. The Lauderdale plant repowered in 1993 and began operating more consistently. Since that time, manatees have used this plant in greater numbers (Reynolds 2000). The numbers of manatees using the Lauderdale plant has grown to a point, where for the first time on a January 2000 synoptic survey, more manatees were counted at the Lauderdale plant than at the Port Everglades plant – 124 to 111 respectively. During the 2001 survey the Lauderdale plant had an all time high count of 143 animals. Reynolds (2000b) noted this interesting change in behavior, "the importance of certain locations can change dramatically over time, and it provides some empirical data on this timing of transitions". The growing preference for the Lauderdale plant, maybe due to the new consistency of warm water in the cooling canals in conjunction with the lack of human disturbance. Reynolds also speculates that this preference would be manifested primarily in females and calves. In 1999-2000 the FPL-Lauderdale had the highest increase in calves for all plants.

The warm-water refuge at the Port Everglades plant is located approximately 7-miles seaward of the Lauderdale plant. Beeler and O'Shea (1988) concluded that in Broward County, the Lauderdale and Port Everglades power plants were the only areas known to be used in numbers by manatees. Despite the fact that these plants are located well within the manatee's winter range, it is debatable as to the level of importance of the Broward County power plants to the winter survival of manatees. Only two cold stress deaths have been recorded in Broward County since 1974 (Mezich 2001). Although the number of cold related deaths is low, this indicates that manatees are not immune to cold weather in southeastern Florida. In addition to being warm-water refugia, these power plants offer respite from heavily trafficked waterways, incidents of human-related harassment.

Manatees that aggregate at the FPL plants in Broward County are known to travel between the Lauderdale and Port Everglades plants as well as other warm-water refugia on the on the east coast of Florida (Deutsch 2000 and MMC 1998). The high single day winter manatee counts for these warm-water are: FPL-Lauderdale (143) and FPL-Port Everglades (276). The last five annual survey counts done at FPL-Lauderdale and FPL-Port Everglades have shown a great deal of variability. Several factors can affect these aerial counts (i.e. weather conditions that affect manatee distribution and poor water clarity). Table #2 presents all of the aerial survey data for FPL-Port Everglades from 1977-2001.

Table #2 – Aerial survey abundance data for FPL-Port Everglades

Survey year	FPL-Port Everglades High Count
1977-1978	114
1978-1979	125
1979-1980	86
1980-1981	110
1981-1982	57
1982-1983	56
1983-1984	35
1984-1985	234
1985-1986	185
1986-1987	182
1987-1988	276
1988-1989	173
1989-1990	227
1990-1991	75
1991-1992	212
1992-1993	70
1993-1994	224
1994-1995	207
1995-1996	13
1996-1997	60
1997-1998	183
1998-1999	60
1999-2000	134
2000-2001	290

Source – Mezich 2001

Foraging

During the winter, water temperature is a primary factor that dictates when manatees leave warm-water refugia and where they forage. Manatees that winter at the Broward county power plants are foraging primarily on aquatic vegetation in Dade County (Mezich 2001). Distribution and abundance of freshwater aquatic vegetation in the area of Broward County power plants is relatively limited and relegated to vegetation growing in canals or on the shoreline, including overhanging plants and trees. In freshwater environments in Dade County, manatees are feeding primarily on the exotic *Hydrilla verticillata*.

Even though manatees may travel in excess of 20 miles to get to foraging areas in Dade County, this is not inordinately farther than distances traveled by manatees on the west coast of Florida to get from warm water refugia to foraging grounds.

Mortality

The causes for manatee deaths in Broward County are varied; however, Broward County does not have any cause of death category that ranks as one of the highest in the state. Deaths related to cold stress have been almost non-existent over the past 25 years of record keeping, with only three being reported in that time period. Port Everglades is well within the historic range for the Florida manatee described by Moore (1951b). Water temperatures seldom reach stressing levels for extended periods of time and the power plants in Broward County have likely ameliorated cold related stress. Table #3 depicts the manatee mortalities reported for Broward County since 1974.

The highest number of manatee deaths in Broward County result from watercraft interactions. Over half of the deaths related to this category are concentrated within a 1.5-mile radius of Port Everglades. The amount of deaths in this area is likely due to high recreational and commercial vessel traffic converging with a manatee travel corridor. In the vicinity of these deaths there are two power plants, an inlet, a port, and a major manatee migration corridor (Mezich, 2001).

Broward County has also had six floodgate deaths since 1974, but only one in the last five years. Floodgates often have qualities that are attractive to manatees. Freshwater is often available at floodgates as are slightly warmer the ambient water temperatures. An example of this situation is the floodgate on the Little River in Dade County. This site is known to attract manatees during mild portions of winter. This location has a 1-degree Celsius higher water temperature than surrounding areas and freshwater is available (Deutsch 2000). Also, freshwater vegetation is often washed down from upriver and made available when the gates are opened. Overall, Broward County ranks 10th out of 43 counties that have documented manatee deaths.

The Corps and the South Florida Water Management District (SFWMD) have identified 17 water control structures in Broward County needing to have manatee protection devices installed. The Corps will be starting work on two of these structures (S-13 and S-33) in the near future (Overstreet, pers. comm. 2002). The locations of all water control structures in Broward County, operated by the SFWMD, are shown in Figure 2. Structure S-13 is located on the DCC, and by placing the manatee protection device at this structure, manatees transiting the DCC will be less likely to die as a result of crushing or entrapment in the structure.

Figure 2 - Locations of Water Control Structures in Broward County

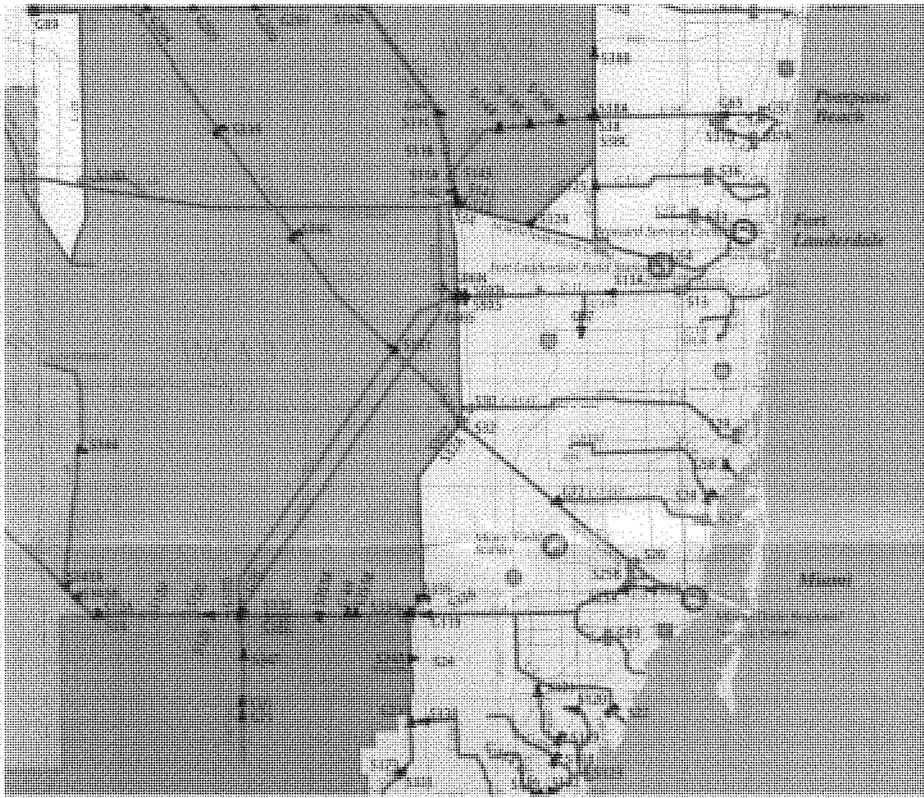


Table #3 – Manatee deaths in Broward county 1974-2001

Year	Watercraft	Flood Gate/ Canal Lock	Other Human	Perinatal	Cold Stress	Natural	Undetermined	Unrecovered	Total
1974	0	0	0	0	0	0	1	0	1
1975	1	0	0	0	0	0	0	0	1
1976	1	0	0	0	0	0	0	0	1
1977	0	0	1	1	0	0	2	0	4
1978	0	0	0	1	0	0	0	1	2
1979	0	0	0	0	0	0	2	0	2
1980	2	1	0	2	0	0	1	4	10
1981	1	0	0	0	0	0	1	0	2
1982	2	1	0	0	0	0	1	0	4
1983	1	0	0	0	0	1	0	0	2
1984	2	0	0	0	0	0	3	0	5
1985	0	1	2	0	0	0	1	0	4
1986	2	0	0	2	1	0	0	1	6
1987	5	0	0	0	0	0	1	0	6
1988	2	0	0	0	1	1	0	0	4
1989	3	0	1	1	0	0	0	0	5
1990	1	0	0	0	0	0	0	0	1
1991	2	1	0	0	0	0	0	0	3
1992	2	0	0	5	0	0	2	0	9
1993	2	0	0	1	0	0	1	0	4
1994	3	0	0	1	0	0	0	0	4
1995	0	1	0	4	0	0	0	0	5
1996	1	0	0	2	0	2	2	0	7
1997	0	0	0	1	0	2	2	0	5
1998	2	1	0	2	0	2	2	0	9
1999	5	0	0	4	0	5	5	0	19
2000	2	0	0	1	0	1	1	0	5
2001	4	0	0	3	1	0	0	0	8

Description of suitable manatee habitats within the action area

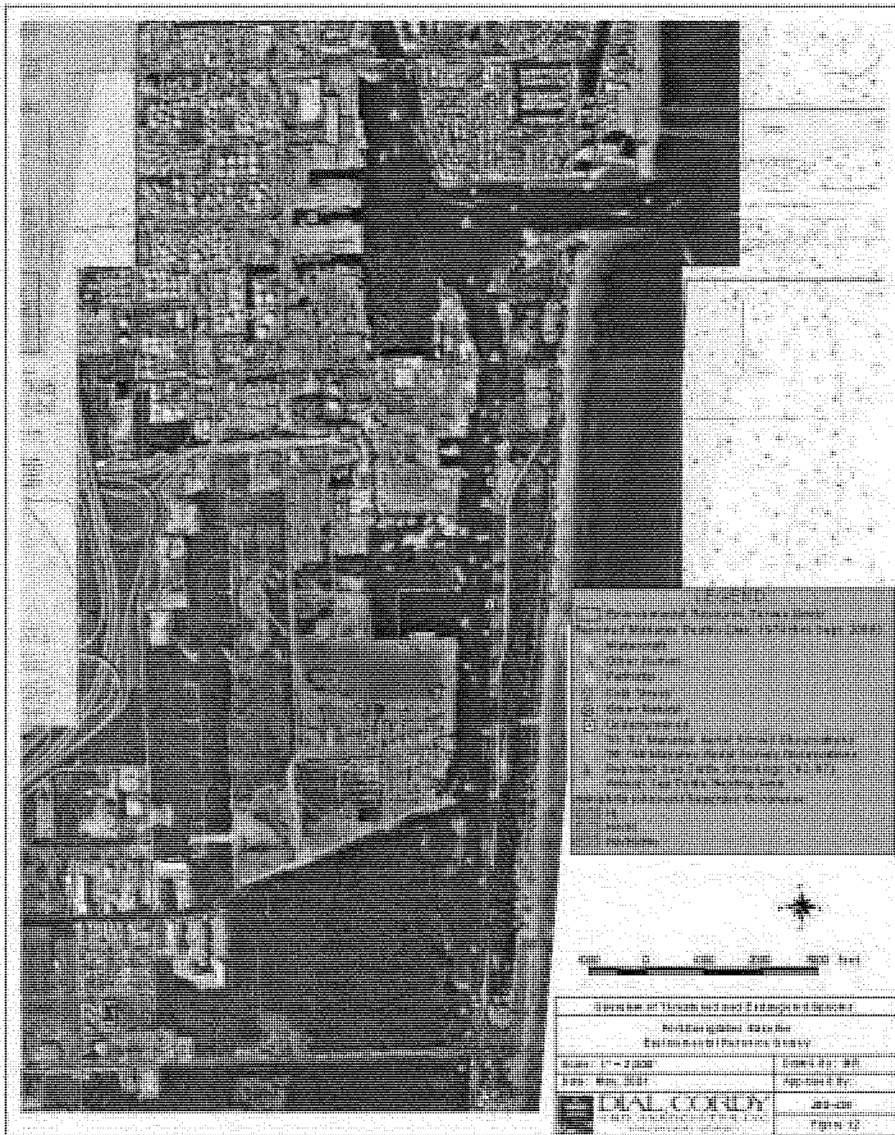
Manatees occur in both fresh- and saltwater habitats within tropical and subtropical regions. They depend on areas with access to natural springs or manmade warm water and access to areas with vascular plants and freshwater sources. Several factors contribute to manatee distribution. These factors are habitat-related and include proximity to warm water during cold weather, aquatic vegetation availability, proximity to channels of at least 2m in depth, and location of fresh water sources (Hartman 1979).

Manatees are also dependant upon location of foraging sites. As previously discussed, radio-tracking of manatees at the Port Everglades power plant has shown that they transit south, into Dade county to forage due to the lack of foraging area available to them near the power plant.

Manatees often seek out quiet areas in canals, lagoons or rivers. These areas provide habitat not only for feeding, but also for resting, cavorting, mating, and calving. Deeper channels are often used as migratory routes (Kinnaird 1983). Manatees seek out natural or artificial freshwater sources, especially manatees that spend time in estuarine and brackish water (FWS 1996).

The former "EPA slip" within the Port has been identified as an area of high manatee useage, and has been documented as a site utilized by calving mothers (Port Everglades, 2002). Figure #3 displays the location of manatees sighted during aerial surveys conducted from 1988 – 1992.

Figure 3 – Manatee locations – Aerial Surveys



Protective Measures taken in the project area separate from conservation measures the Corps will take as part of the proposed action

Port Everglades
Port Everglades has taken numerous steps to reduce manatee-human interaction, injury and mortalities within the port. The port has spent more than $600,000 to increase protective measures for manatees within the port (Sosnow 2002 pers.comm). These steps have included:

- Posting of manatee warning and speedzone signage throughout the Port.
- The Port desigated the former "EPA slip" in the FPL discharge canal as a "Manatee Nursery Area" to restrict the area's use from boaters and the general public. The area has been documented as a site utilized by calving mothers (Port Everglades 2002).
- Development and implementationof a Manatee protection plan for use during dredging for use during dredging activites within the Port.
- Development and implementation of a Manatee protection plan for use during blasting activites within the Port.
- Manatee Lagoon Improvements – the Port deepened tha lagoon and the water below the mangroves adjacent to the FPL canal. Thes improvements allow manatees to stay in the lagoon during all tidal stages; as well as increasing flushing of warm water into the area. The port also placed floating barricades and signage to keep the public out of the area. The area has been documented as a site utilized by calving mothers (Sosnow 2002 pers.comm.).
- Lagoon Protection at the John U. Lloyd State Recreation Area.
- Funding of research on manatees within the port conducted by the FWS and the Miami Seaquarium and other researchers (White, Reynolds, Fleetameyer).
- Participation in law enforcement activities to prevent harrassment of manatees by individuals swimming with them.
- Each year before the manatee "season" (Nov 15-Mar 31) begins, the Port sends letters to tug companies and pilots reminding them about the upcoming season and about the protective measures that the port has implemented to protect manatees in the port.
- The port has placed fenders throughout the entire port at 50 ft centers to fender off ships – when a ship is tied to the bulkhead, the fender is approximately 4 feet in width. These fenders prevent manatees from being crushed between the ships and the bulkhead walls.
- Development of outreach programs and materials including brochures, seminars and public talks. The port opened a platform/sea life viewing area to educate the public about the manatees and other animals that are in the port. 400,000 people visited the platform in one year. This viewing area caused traffic and parking problems near the port and had to be closed.

Broward County
Broward County is one of 13 Florida counties required to have a manatee protection plan developed under the Local Government Comprehensive Planning and Land Development Regulation Act (LGCPALDRA) of 1985. The LGCPALDRA requires these plans include speed and no entry zones, boat facility siting policies and other measures to protect manatees. Broward

County has prepared a plan, and incorporated it into the county's "Comprehensive Plan". These plans are submitted to the State, through the Florida Fish and Wildlife Conservation Commission, and to the Federal government through the US Fish and Wildlife Service. As of November 2001, neither the state nor the USFWS had approved the Broward County plan (USFWS 2001). The county's Manatee protection element of the comprehensive plan is located in the "Conservation Component" of the plan (Chapter 13, book 2).

Speed & No Entry Zones
Seasonal no-entry zones around the power plants were created in 1979 and amended in 1983. A Broward County wide speed zone rule was adopted in May 1993 (68C-22.010, Florida Administrative Code). Placement of speed zone signage for the Broward County rule was completed in October 1994. The County has worked with FPL to restrict or prohibit access to certain waterways and waterbodies that appear to be manatee high use areas.

Boating facility Siting Policies
The LGCPALDRA requires "manatee" counties to prepare policies concerning the siting of boating facilities. The County has not taken an approach to boat facility siting since it is considered built out (Arnold 2001). New facilities are likely to be conversions of either existing property to multifamily residential or the redevelopment of commercial facilities to accommodate larger vessels usually by lowering the number of slips at a site (Arnold 2001). Therefore, new boat facility development and the expansion or conversion of of existing facilities will be reviewed for impacts to manatees and their habitat through normal state permitting. The County will provide guidance to potential boat facility developers by guiding them to be consistent with the plan and to incorportate Best Management Practices within their application.

Designation of Essential Habitat for Manatees within the County
Broward County has identified areas to be designated as essential habitat: the FPL plant discharge areas; Port and Whiskey Creek; the Hollywood Canal; the residential canals located approximately one quarter mile west of the Florida Turnpike and immediately north of I-595 (Plantation Isles subdivision), and the Hillsborough Inlet (Arnold, 2001).

Scientific Research on Manatees
Regulations developed under the ESA allow for the taking of ESA-listed manatees for the purposes of scientific research. In addition, the ESA also allows for the taking of listed species by states through cooperative agreements developed per section 6 of the ESA. Prior to issuance of these authorizations for taking, the proposal must be reviewed for compliance with section 7 of the ESA. Research permits for manatees are issued by the FWS' headquarters in Arlington, VA (Valade 2002 pers.com). Research activities currently conducted under permit from FWS in the action area include:

- Photo identification study of manatees by the USGS-Sirenia project
- Photo identification study by Dr. Ed Keith of NOVA University
- Carcass recovery and necropsy activities conducted by the State of Florida through the Florida Marine Research Institute's Marine Mammal Pathology Laboratory.

Other consultations of Federal actions in the area to date
The Corps has been working with the citizens of Broward County since 1930 on improving and maintaining Port Everglades Harbor (USACE 2002). The following table lists the improvements authorized by Congress. None of the projects authorized by Congress through 1958 were required to consult under the ESA, it is unknown if a consultation under Section 7 of the ESA was conducted on the 1974 project.

ACTS	WORK AUTHORIZED	DOCUMENTS
3 Jul 1930	Maintenance of harbor constructed by local interests.	H. Doc. 357/71/2
30 Aug 1935	Enlarge entrance channel to existing project dimensions and complete turning basin to 1,200 feet square.	R. & H. Comm. Doc. 25/74/1
20 Jun 1938	Widen turning basin 350 feet on north side.	H. Doc. 545/75/3
24 Jul 1946	Widen turning basin 200 feet on north side, 500 feet on south side, and enlarge flare at entrance channel.	H. Doc. 768/78/2
3 Jul 1958	Deepen and widen entrance channel on a new alignment and increase turning basin in size and depth.	H. Doc. 346/85/2
H.R. 9 May 1974 S.R.31 May 1974	Deepen and widen entrance channel on a new alignment, deepen turning basin and add a new channel to the southeast of the turning basin. This project was completed in 1984.	H. Doc. 144/93/1

Projects completed by the Port without Federal assistance

1987	Port Everglades. Final Environmental Impact Statement, Proposed Expansion Port Everglades, Broward County, Florida. EIS for deepening and widening the Southport Access Channel, bulkheading port land, creation of the Turning Notch. This project was completed

Effects of the proposed action

Direct effects
As previously stated, during winter months a large population of manatees uses the warm water refuge at the FP&L Power Plant at Port Everglades and at the Lauderdale power plant at the end of the DCC.

The highest potential to directly effect endangered manatees may be the use of explosives to remove areas of rock within the Entrance Channel and Southport Access Channel. Both the pressure and noise associated with blasting can injure marine mammals. Noise and pressure effects to manatees have not been well documented, however, it is assumed that manatees will be impacted similar to dolphins, where documentation is available.

Blasting

To assess and reduce the effects of blasting on endangered, threatened and otherwise protected species, the Corps contracted with Dr. Calvin Konya, Precision Blasting Services, to review previous Corps blasting projects, recommendations of Florida Fish and Wildlife Conservation Commission (FFWCC) (then known as the Florida Department of Natural Resources) and the U.S. Fish and Wildlife Service (FWS) prepared for a harbor deepening project at Port Everglades, Florida conducted in the mid 1980's. A copy of this plan has been previously provided to the FWS during coordination activities on this action.

Historic Blasting in Port Everglades and Manatee Protections

During the consultation process on the 1983 blasting in Port Everglades, the FWS and FFWCC recommended that a formula proposed by Johnson, Commander, USN and Project Manager and Coordinator of OICC TRIDENT.

An arc having a radius defined by delineated the danger zone:

$$D = (13000\ W^{1/3})/P$$

Where:

D = radius of the danger zone in feet
W = weight of the explosive charge in pounds
P = overpressure created by the explosion shockwave, where
P = 50 psi+ ambient pressure

However, it was later pointed out by an expert in blasting and dredging activities that this formula could not be applied to the Port Everglades blasting project because it was based on an unconfined blast instead of a confined blast. An unconfined blast is defined as an open air or open water blast without any physical restrictions that will slow down its development. A confined blast is usually associated with drilling and blasting within the restrictions of rock strata. As a result of this information, the consultation group rejected the formula.

Alternatively, the physical parameters used during an ongoing dredge project in Kings Bay, Georgia. The physical parameters of distance vs. overpressure for the Kings Bay project were determined by a test blasting conducted between 28 June and 2 July 1983 at Kings Bay, Georgia. Assuming a water overpressure of 50 psi or less would not harm a manatee, the results of the test program indicated that this overpressure would not be exceeded at a distance of 400 feet given a blast of 780 pounds of explosives per day. The Corps also decided to extend the blasting danger zone to 600 feet to ensure a safety margin.

To adequately ensure the safety of manatees while blasting, a 14-point plan was developed. Agencies involved in designing this plan include FFWCC, FWS, the Corps and the Florida Audubon Society. The manatee protection program used during the Port Everglades harbor deepening project in the mid-1980's was successful and will be used as a model in the upcoming project.

Aerial surveys were conducted prior to the beginning of the blasting project. A Bell helicopter was used to survey the Port area on three consecutive days prior to the beginning of the blasting. Provisions were included in a "Manatee Protection Plan" stated that if more than five (5) animals were observed on those surveys, the project would be delayed until the number of animals fell below five. The surveys were flown at ground speed, which ranged between 10 kts and 60 kts and at an altitude that ranged between 50 meters and 200 meters.

Results of the 1983 blasting in Port Everglades
During the period between 4 April and 8 May when this program was in operation, a total of 58 manatee sightings were made on 28 separate occasions were made. A table of these observations is included in Konya (2001) (Table #2). Three of these sightings were made with the fathometer, while the remaining 25 were visual observations made by either the boat observer or observers stationed on the drill barge.

These observations necessitated shutting down the blasting operation for a total of 14 times and for a total of 222 minutes, the average time being 15 minutes, 12 seconds. On April 19, 1984, because of the number of manatees observed near the dynamite drill barge, the operation was shut down prematurely and was not resumed until the next day.

Possibility for injury or mortality in mammals in the project area
To protect mammals (manatees and dolphins), the following relationship has been used in the past and has been into previous Corps dredging projects. This formula is based on the Navy Diver Formula, which is designed for unconfined charges.

Caution zone radius = $260(\text{lbs/delay})^{1/3}$

Safe zone radius = $520(\text{lbs/delay})^{1/3}$

The caution zone is the radius from the blast where mortality will not occur.

New data obtained from the 1983 Port Everglades blasting project indicates that the Navy Diver Formula is extremely conservative for predicting safe distances from the charges that are placed in boreholes. In his report, Koyna (2001) proposes a new formula that incorporates actual measurements of pressures generated from underwater blasts with explosives in boreholes. The new equation is:

Caution zone = $132(\text{lbs/delay})^{1/3}$

Safe zone radius = $56(\text{lbs/delay})^{1/3}$

The Corps plans to utilize this new formula in the proposed blasting at Port Everglades. Additionally, the Corps will prepare a marine mammal and sea turtles protection plan similar to the one used in the previous deepening project will be employed. Based on the previous mid-1980 program a 600 feet safety zone will be used. Trained, experienced observers would monitor the safety zone by helicopter, high vantage points, and boat. Examples of the provisions to be included in the protection plan are included below:

In order to provide dependable verification of presence of manatees within the blast zone, a detection system was designed which included the following three provisions:

- Provision 7: A trained observer will be stationed on the sighting tower or catwalk of the dynamite drill barge.

- Provision 8: An observer in a boat will make a systematic survey of the danger zone prior to blasting.

- Provision 9: An electronic color enhanced fathometer will be utilized to monitor underwater manatee movement.

Additionally, special conditions will be placed into the specifications for the project to protect manatees in the area.

1. A marine mammal watch will be conducted by no less than 2 qualified observers from a small watercraft, at least ½ hour before and after the time of each detonation, in a circular area at least three times the radius of the above described danger zone (this is called the watch zone).
2. Any marine mammal(s) in the danger zone or the watch zone shall not be forced to move out of those zones by human intervention. Detonation shall not occur until the animals(s) move(s) out of the danger zone on its own volition.
3. No blasting will occur in the south channel during the "manatee season".
4. In the event a marine mammal or marine turtle is injured or killed during blasting, the Contractor shall immediately notify the Contracting Officer as well as the following agencies:
    a. Florida Marine Patrol "Marine Mammal Stranding Hotline" 1-800-342-5367
    b. FWS – Vero Beach Office
    c. National Marine Fisheries Service – Protected Resources Division, St. Petersburg

Other Rock Removal Options

The Corps investigated methods to remove the rock in Port Everglades without blasting using a punchbarge. It was determined that the punchbarge, which would work for 12-hour periods, strikes the rock below approximately once every 30-seconds. This constant pounding would serve to disrupt manatee behavior in the area, as well as impact other marine animals in the area. Using the punchbarge will also extend the length of the project temporally, thus increasing any potential impacts to all fish and wildlife resources in the area.

The Corps believes that blasting is actually the least environmentally impactful method for removing the rock in the Port. Each blast will last no longer than 25 seconds in duration, and may even be as short as 2 seconds, and will be spaced out twelve hours apart. Additionally, the blasts are confined in the rock substrate. Boreholes are drilled into the rock below, the blasting charge is set and then the chain of explosives is detonated. Because the blasts are confined within the rock structure, the distance of the blast effects are reduced as compared to an unconfined blast.

Indirect effects
The regulations for interservice consultation found at 50 CFR 402 define indirect effects as "are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur". The Corps does not believe that the project will have any indirect effects on manatee in the action area.

Effects of interrelated and interdependent actions
The regulations for interservice consultation found at 50 CFR 402 define interrelated actions as "those that are part of a larger action and depend on the larger action for their justification" and interdependent actions as "those that have no independent utility apart from the action under consideration."

The Corps does not believe that there are any interrelated actions for this proposed project; however, the recommended plan for Port Everglades contains widening components and deepening components. As a result of the widening components of the project, larger container vessels will call at Port Everglades. As a result of both the widening and the deepening components of the project, more tonnage will be carried per vessel call, so the total number of vessel calls will be reduced (Dawedit 2002. pers comm.). This will be an indirect benefit to the manatees since there will be fewer ships in the area to potentially affect them. Additionally, the wider channel will provide manatees more room to maneuver around incoming and outgoing vessels throughout the action area.

The Corps believes that the increase in size within the Port will not have an adverse effect on manatees in the area for three reasons:

1) Recent data shows that manatees are not using the Port itself as a primary habitat. Aerial surveys conducted between 1988-1992 show that very few manatees use the area of the Port proper. They congregate in the canal to the Port Everglades power plant, as well as in the "EPA slip" – both of which are located south of the Port (Figure 2);
2) The Port has developed a manatee protection plan and implemented items included in the plan – including the placement of 4-ft wide bumpers along the slips to hold ships 4-feet away from the bulkheads, thus reducing the potential for a manatee to be crushed by a ship; The Port has also put into place regulations drafted by the state that requires ships to travel at the slowest speed possible that maintains steerage, and
3) Fewer manatees are utilizing the Port Everglades power plant as a winter thermal refuge – so there are fewer animals in the area that could be affected by the project.

Cumulative effects
The regulations for interservice consultation found at 50 CFR 402 define cumulative effects as "those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consideration." The Corps is not aware of any future state or provate activites, not involving Federal activities that are reasonably certain to occur within the action area."

Take Analysis
Due to the restrictions and special conditions placed in our construction specifications the Corps does not anticipate any take of the endangered Florida manatee.

Determination
The Corps has determined that the proposed expansion and deepening of Port Everglades Harbor is likely to affect, but not likely to adversely affect listed species within the action area. The Corps believes that the restrictions placed on the blasting previously discussed in this assessment will diminish the effect of the project on protected species within the action area.

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FOR CONTINUATION OF HOUSE DOCUMENT 114-104

PORT EVERGLADES BROWARD COUNTY, FLORIDA
ENVIRONMENTAL FEASIBILITY REPORT AND ENVIRONMENTAL
IMPACT STATEMENT

SEE PART 3