Regional Marsh Management Strategies for the Indian River Lagoon

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A. INTRODUCTION

Over 16,000 ha of productive coastal salt marshes and mangrove forests[1] along the Indian River Lagoon have been impounded for mosquito control. Research during the past 10 years, has shown that impounding can have severe environmental impacts on the marshes and the adjoining estuary. Of particular concern are degradation of water quality, isolation of habitat needed by sport and commercially important fishery species during critical times in their life cycles, elimination of productive marsh vegetation, adverse impacts on estuarine seagrasses, and interruption of the free flow of nutrients and organisms between wetlands and the lagoon.

The same body of research, however, has been used to develop management techniques that mitigate many of these adverse effects while retaining the capability to control mosquitoes without having to use potentially harmful pesticides in these fragile areas. Some of these techniques, such as Rotational Impoundment Management (RIM), have been tested and used repeatedly in the lagoon, while others with equal or greater potential for effecting different environmental benefits have been implemented only infrequently. The major reason for this is that there are no comprehensive, lagoon-wide management strategies that take into account the suitability of individual areas for different purposes and the types of management strategies being used in surrounding areas.

Along with the research data available on which to base management decisions, a successful mechanism has been established to promote wise, multi-resource management of Florida's wetlands resources. This vehicle is the legislatively established (F.S. Chapter 388) Subcommittee on Managed Marshes (SOMM), an interagency committee with representatives from : (1) agencies responsible for wetlands resources, (2) institutions involved in wetlands and estuarine research, and (3) agencies responsible for mosquito control (Appendix A). This committee, first established in 1983, is regarded by many as one of the finest examples of interagency cooperation to achieve wide-based consensus on ecologically-sound wetlands management solutions.

For several years, SOMM has endorsed the concept of "block management". This concept involves the grouping of impoundments and marshes into geo-politically and ecologically meaningful "management areas", and applying different management techniques to various members of the group. To date, SOMM has completed management plans for one such area along the lagoon, The

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[1] For simplicity, we will use the term "marsh" to refer to habitats variously known as salt marshes, coastal wetlands, mangrove forests, mangals, etc. Distinctions among these will only be made when necessary.

Sebastian Inlet Management Area (SIMA), a region extending from CR 510 in Indian River County north to Hog Point, in Brevard County. The St. Johns River Water Management District, through their Surface Water Improvement and Management Program (SWIM) has funded the implementation of most parts of the management plan in cooperation with the Indian River and Brevard Co. Mosquito Control Districts.

However, without a comprehensive, lagoon-wide management strategy, the block management technique will not be widely applied because impoundment management continues to take place on an impoundment by impoundment basis. As a result, opportunities for improving environmental conditions in the lagoon are being squandered. Areas are often not managed in the best possible way, and many adjoining wetlands are managed identically (usually under the RIM protocol) when there may be dire need for alternative management in the area (e.g., for wading or migratory birds, endangered species, wildlife management, stormwater retention, etc.).

This project continues development of Lagoon-wide management strategies by identifying and delineating all the appropriate management areas in the Indian River Lagoon, and by developing specific management strategies for three of these areas.

The quarterly meetings of SOMM have provided the forum for discussion, fine-tuning, reviewing, and adopting the resulting plans. This process assures broad agency input into the resulting documents. In addition, presentations on this project have been made to a number of groups with special interest in the Indian River Lagoon (Appendix B) and their input has been solicited.

The approach to development of management strategies has been based upon the need to achieve a balanced overall strategy that takes into consideration current impacts and that is not overly biased towards one type of management. The heavy human impacts already imposed upon the lagoon and its marshes makes it imperative that we consider current problems and solutions in view of certain constraints placed upon our management capabilities by human activities. An attempt has been made to increase marsh-lagoon linkage, but other conflicting needs have not been ignored.

ACKNOWLEDGMENTS: Numerous people have contributed to this project. We would specially like to thank David Mook and Jody Rosier, who wrote important sections of this document. We also thank the members of SOMM for the many hours of discussion that considerably improved the final product. Personnel from Volusia, Brevard, Indian River, St. Lucie and Martin Co. Mosquito Control and from the Merritt Island National Wildlife Refuge were extremely helpful in providing information and comments. In

particular, we would like to thank Paul Haydt, Scott Taylor, Pete O'Bryan, Jim David, Blake Faulkner, and Harvey Hill for their help with the project. Finally, we thank the members of the special interest groups listed in Appendix B for their input. This project was funded by a Coastal Zone Management Grant (NOAA), administered by the Florida Department of Community Affairs.

B. RESOURCES/ATTRIBUTES

Below is a list of resources and attributes that were considered important when developing management strategies.

1. Seagrasses
2. Rookeries
3. Waterfowl wintering areas
4. Freshwater sources, natural & man-made
5. Inlets
6. Development
7. Vegetation (open vs closed canopy)
8. Mosquito control activities & problems
9. Endangered species habitat
10. Wading bird utilization
11. Shore birds
12. Public use
13. Educational facilities/potential
14. Research facilities/potential
15. Tidal range
16. Elevation profile
17. Fishery habitat potential
18. Existing water quality

C. MANAGEMENT OBJECTIVES

What follows is a list of possible management objectives for marshes along the lagoon. The list is not meant to be an all-inclusive compilation of management options, but rather an example of the types of goals that can be addressed through proper management.

1. Mosquito Control
2. Wintering waterfowl management
3. Linkage and interchange with lagoon - import/export
4. Fish
    a) Access and nursery for transient, sport & commercial species
    b) "Stock enhancement"
    c) Promote diversity
5. Wading bird management
6. Mammals
7. Endangered species
    a) Wood stork
    b) Atlantic saltmarsh snake
    c) Diamondback terrapin
    d) Other
8. High salt marsh species
    a) Vegetation
    b) Fiddler crabs
    c) Clapper rail
    d) Other
9. Exotic vegetation management/control

10. Water quality

    a) Storm water treatment and flood storage

    b) Maintenance of desired water quality by pumping and promoting circulation

    d) Reduction of pesticide application

11. Invertebrates: Management and culture

    a) Promote diversity

    b) Stock enhancement

12. Recreation

    a) Fishing, crabbing

    b) Bird watching

    c) Other

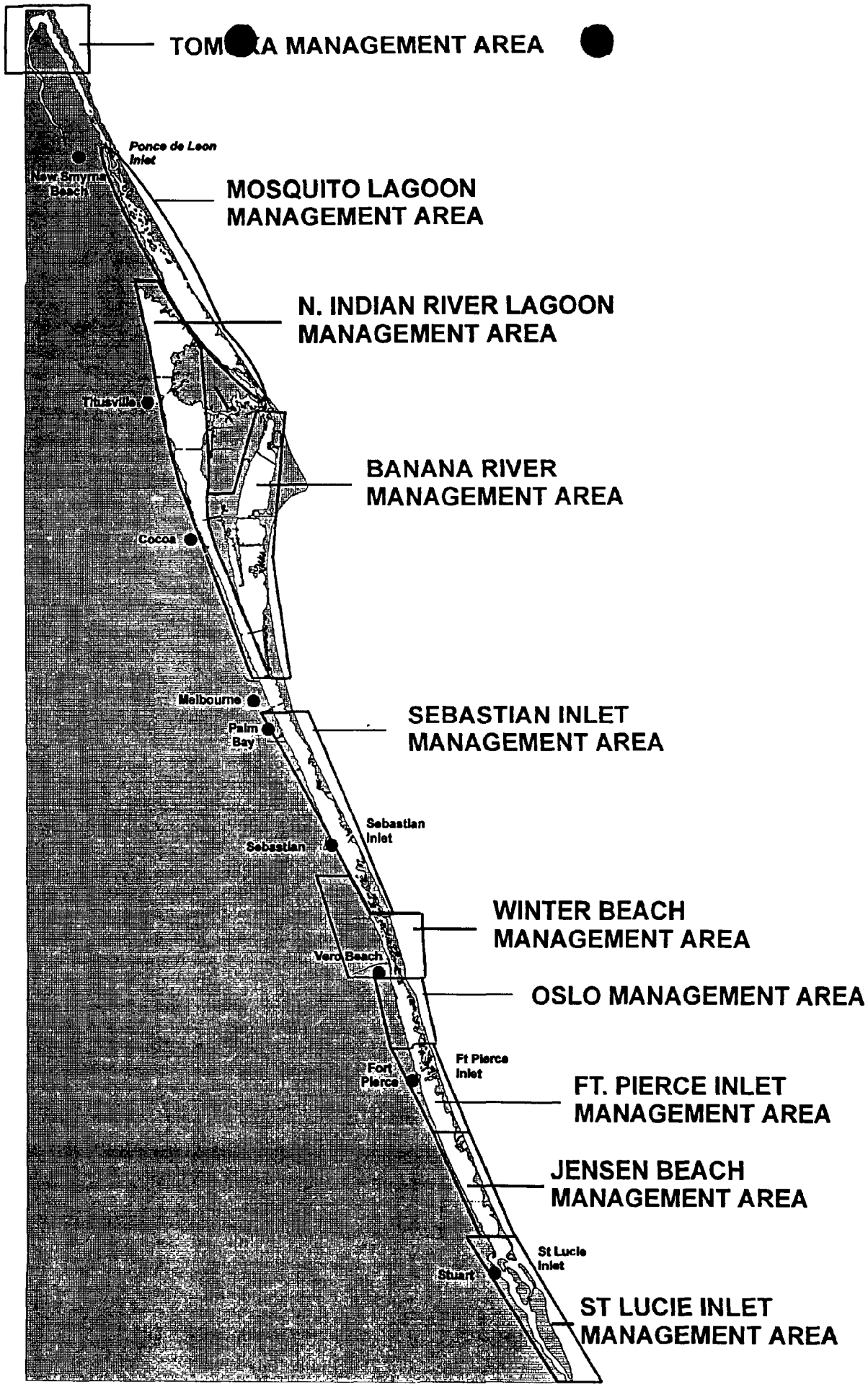
13. Education

14. Research

D. LAGOON MANAGEMENT AREAS

The following segmentation scheme has been devised to group together marshes within functionally discrete areas of the lagoon. Below are description of each of the resulting 10 Lagoon Management Areas (LMAs), with tables showing the impoundments in each area, their areal extent (in hectares), and the current management of each. The ten areas are delineated in a map of the lagoon, followed by more detailed maps of each of the areas.

In the tables summarizing LMAs covering the Merritt Island National Wildlife Refuge (MINWR) FALL/WINTER DRAWDOWN has been abbreviated as F/W DRAWDOWN.


TOMOKA MANAGEMENT AREA
Ponce de Leon Inlet
New Smyrna Beach
MOSQUITO LAGOON MANAGEMENT AREA
N. INDIAN RIVER LAGOON MANAGEMENT AREA
Titusville
BANANA RIVER MANAGEMENT AREA
Cocoa
Melbourne
Palm Bay
SEBASTIAN INLET MANAGEMENT AREA
Sebastian Inlet
Sebastian
WINTER BEACH MANAGEMENT AREA
Vero Beach
OSLO MANAGEMENT AREA
Ft Pierce Inlet
Fort Pierce
FT. PIERCE INLET MANAGEMENT AREA
JENSEN BEACH MANAGEMENT AREA
St Lucie Inlet
Stuart
ST LUCIE INLET MANAGEMENT AREA

TOMOKA MANAGEMENT AREA

The Tomoka Management Area consists of a single impoundment (A-2, Volusia County) of approximately 445.5 ha. it is bounded to the north by tributaries of Bulow Creek, on the east by the Halifax River, on the south by unimpounded marshes and the Tomoka Basin, and on the west by woodlands which are drained by ditches that flow into Tomoka Basin.

The west side of the area borders on Bulow State Park, whereas the areas below mean high water form part of the Tomoka Marsh Aquatic Preserve. There is no development around this area, but there is considerable recreational use, particularly on the south side (fishing, crabbing, camping).

In the past, the marsh was extensively ditched for mosquito control, and the ditches are still evident today. There is a large breach (12-15 m) on the north end of the dike, and a spoil deposition area along the east border. The Florida Inland Navigation District (FIND) has proposed to expand this spoil area and to improve the road leading to it (including installation of culverts below the road). There are also plans to purchase and preserve the whole area as mitigation for the spoil deposition, a project that FIND and Aquatic Preserve personnel consider of high priority.

The marsh vegetation is composed primarily of *Distichlis spicata* and *Salicornia* spp., with *Avicennia germinans, Spartina bakeri* and *Juncus roemerianus* occurring irregularly throughout the marsh. Along the ditches, vegetation consists of *Salicornia* and *Borrichia*, with numerous *Opuntia, Distichlis*, and a few cedar trees. Freshwater species such as *Typha* and *Scirpus* are found along the western boundaries, whereas palms, pines, and hardwoods with dense palmetto undergrowth occur on hammocks and high islands within the marsh.

From 1968 to 1972, the area was seasonally flooded for mosquito control and high water levels were maintained during winter to provide waterfowl habitat. From 1972 to 1980, the winter management was discontinued, and in 1980 all management ceased.

Table 1. Impoundments within the Tomoka Management Area

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
A2 - TOMOKA	445.5	UNMANAGED

MOSQUITO LAGOON MANAGEMENT AREA

The Mosquito Lagoon Management Area (MLMA) extends from approximately 20 miles north of Ponce Inlet (Volusia County) south for approximately 55 miles thereby including impoundments along both the eastern and western edge of Mosquito Lagoon. The MLMA thus encompasses the Mosquito Lagoon Aquatic Preserve (MLAP), the Canaveral National Seashore's (CNS) marshes (which are located in Volusia County). The southern Mosquito Lagoon region in Volusia and Brevard Counties, includes part of the Merritt Island National Wildlife Refuge (MINWR) which borders Mosquito Lagoon.

NOTABLE FEATURES WITHIN MLMA. The fact that most of the MLMA marshes are publicly owned (as part of the MLAP, the CNS or MINWR, makes this management area unique among the 10 management areas delineated. Because so much marsh property, in particular within the CNS is not impounded presents opportunities for management other than the more typical Rotational Impoundment Management employed in many impounded marshes along the lagoon. Also, Ponce Inlet provides a tidal exchange between the Atlantic Ocean and the north portion of this lagoonal management area. Development is minimized along this management area and because so much of the area is publicly owned, future development pressure in many areas is limited. The Mosquito Lagoon marshes are typically vegetated with *Salicornia spp.* (glasswort), *Batis maritima* (saltwort) and *Distichlis spicata*, with occasional *Avicennia germinans* (black mangrove) and *Laguncularia racemosa* (white mangrove). In contrast, in southern regions of the Indian River lagoon, marsh vegetation is often dominated by mangroves.

VOLUSIA COUNTY COMPONENT OF MLMA. In Volusia County, the MLMA includes 10 impoundments totalling 1878 acres part within the CNS (C-8, D-2, D-12N, D-12S) and the others in the MINWR (V1-V5 & T45 (which straddles the 2 counties)). Also included are several unimpounded marshes, largely within the CNS.

IMPOUNDMENTS. The 10 MLMA impoundments in Volusia County are currently managed in a variety of ways. The CNS impoundments include: 1) Open Marsh Water Management (OMWM) with and without rotary ditches, 2) an impoundment connected to the lagoon through culverts and 3) one totally unmanaged (this includes no use of mosquito larvicides on the marsh)and 4) one larvicided on a need basis. Four of the six MINWR impoundments (V1-V5) currently maintain culvert connections to the lagoon with little other management. Six more culverts will be installed in this group of impoundments in the future.

UNIMPOUNDED MARSHES. The unimpounded marshes within CNS include both unditched and previously ditched marshes some of which currently require periodic larvicide treatments to control salt-marsh mosquito populations.

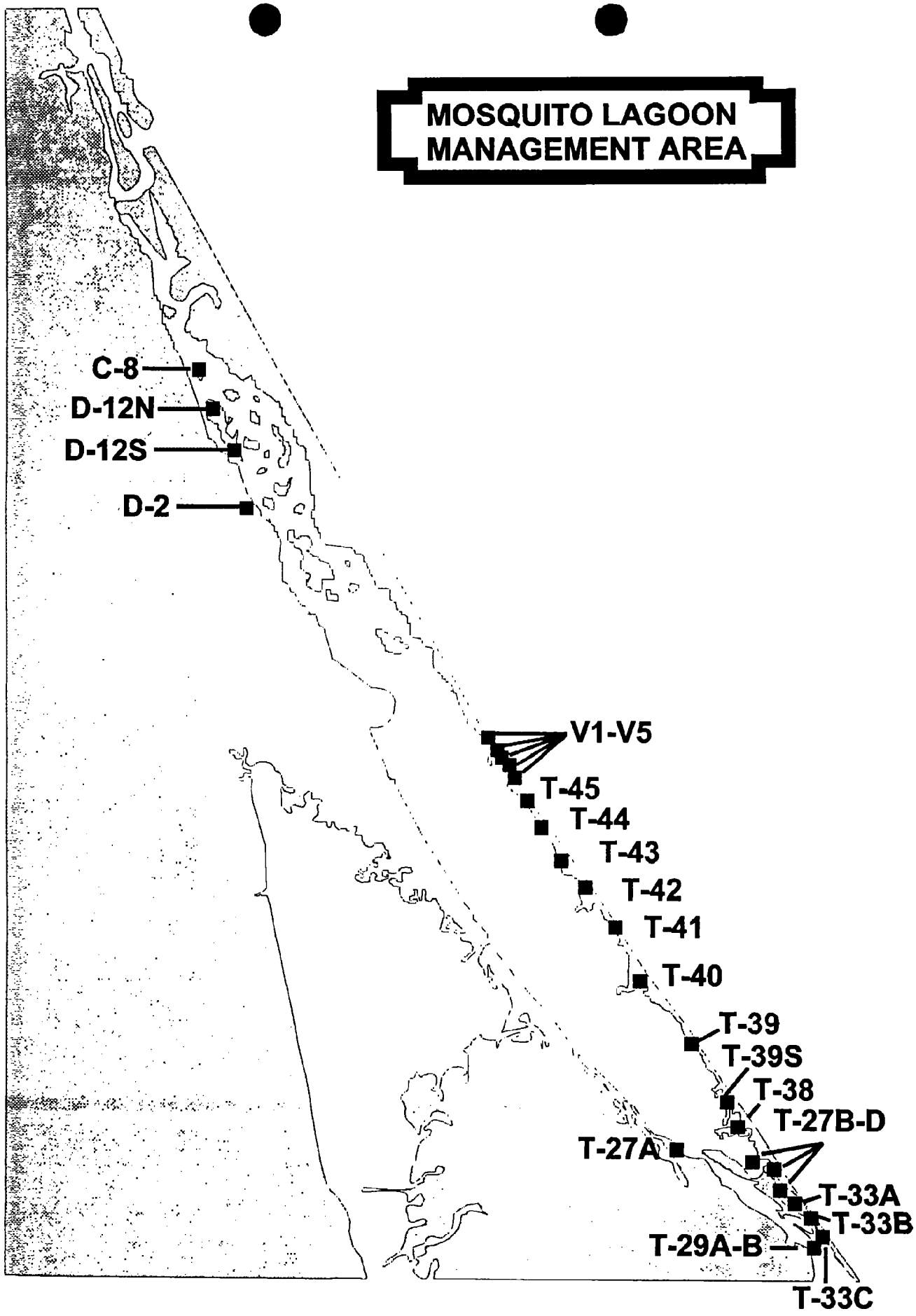
BREVARD COUNTY COMPONENT OF MLMA. In Brevard County, the MLMA includes 18 impoundments (T27A-T45) totalling 5450 acres. Management of this large acreage, which is along both sides of the lagoon within the MINWR, is split with approximately half of the impoundments being largely unmanaged with only an occasional larvicide application, and the others maintained with elevated water levels.

Table 2. Volusia County Impoundments within the Mosquito Lagoon Management Area. CNS = Canaveral National Seashore, VC = Volusia County, BC = Brevard County, MINWR = Merritt Island National Wildlife Refuge.

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
C-8 (CNS/VC)	36.9	OMWM (BREACHED W/R.DITCHES)
D-2 (CNS/VC)	38.9	OPEN WITH 4 CULVERTS
D-12N (CNS/VC)	17.4	UNMANAGED
D-12S (CNS/VC)	100.4	OMWM (BREACHED)
V-1 (MINWR/VC)	216.3	OPEN WITH 1 CULVERT
V-2 (MINWR/VC)	79.4	OPEN WITH 1 CULVERT
V-3 (MINWR/VC)	163.2	OPEN WITH 1 CULVERT
V-4 (MINWR/VC)	64.8	F/W DRAWDOWN
V-5 (MINWR/VC)	19.9	F/W DRAWDOWN - OPEN
T-45 (MINWR/VC/BC)	23.5	OPEN

Table 3. Brevard County Impoundments within the Mosquito Lagoon Management Area. VC = Volusia County, BC = Brevard County, MINWR = Merritt Island National Wildlife Refuge.

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
T-45 (MINWR/VC/BC)	23.5	LARVICIDED
T-44 (MINWR/BC)	121.5	UNMANAGED
T-43 (MINWR/BC)	225.2	UNMANAGED
T-42 (MINWR/BC)	45.0	UNMANAGED
T-41 (MINWR/BC)	20.3	UNMANAGED
T-40 (MINWR/BC)	134.1	UNMANAGED
T-39N (MINWR/BC)	10.1	UNMANAGED
T-39S (MINWR/BC)	39.3	UNMANAGED
T-38 (MINWR/BC)	115.0	UNMANAGED
T-33C (MINWR/BC)	48.6	ELEVATED WATER LEVELS MAINTAINED
T-33B (MINWR/BC)	53.9	ELEVATED WATER LEVELS MAINTAINED
T-33A (MINWR/BC)	43.3	ELEVATED WATER LEVELS MAINTAINED
T-29B (MINWR/BC)	41.7	ELEVATED WATER LEVELS MAINTAINED
T-29A (MINWR/BC)	37.3	ELEVATED WATER LEVELS MAINTAINED
T-27D (MINWR/BC)	260.1	ELEVATED WATER LEVELS MAINTAINED
T-27C (MINWR/BC)	238.1	ELEVATED WATER LEVELS MAINTAINED
T-27B (MINWR/BC)	292.8	ELEVATED WATER LEVELS MAINTAINED
T-27A (MINWR/BC)	557.3	ELEVATED WATER LEVELS MAINTAINED


MOSQUITO LAGOON
MANAGEMENT AREA
C-8
D-12N
D-12S
D-2
V1-V5
T-45
T-44
T-43
T-42
T-41
T-40
T-39
T-39S
T-38
T-27B-D
T-27A
T-33A
T-33B
T-29A-B
T-33C

N. INDIAN RIVER LAGOON MANAGEMENT AREA

The North Indian River Lagoon Management Area extends from the northern end of Indian River Lagoon at the Turnbull Creek marshes in Volusia County southward to the town of Cocoa on the Mainland Side and through the Shiloh and T-10 marsh impoundments on the east side on Merritt Island adjacent to the Indian River Lagoon. Most of the impoundments are a part of Merritt Island National Wildlife Refuge, and therefore publicly owned. Impounded marsh acreage is 18,024 acres with 283 acres in the 3 Scotsmoor cells 1512 acres in 3 Shiloh cells, and 16,229 acres in the other MINWR impoundment cells that are adjacent to Indian River Lagoon.

Unimpounded marshes stretch southward from the Scotsmoor area to Mims extending inshore to the FEC railroad tracks. Marshes are absent from Titusville southward to Cocoa on the mainland because of the relatively steep bank of the Indian River.

The major features of this area are the shallow waters of the Indian River Lagoon, which average about three feet depth through the entire lagoon cross section. Because of the shallow depth, seagrasses are abundant throughout the area. Fresh water is available to all impoundments in the area from Turnbull Creek, or from runoff from the mainland or Merritt Island. The Scotsmoor and Shiloh groups of impoundments are important features as well as the Haulover connection between the Mosquito Lagoon and Indian River Lagoon.

All the marshes are dominated by herbaceous halophytes because the area is too far north to support an abundance of mangrove vegetation. Because of distance from inlets the supply of juvenile fishes is probably limited, therefore waterfowl are a prime consideration in management planning. There are Sixteen endangered species in the region. Two of these, the endangered wood stork and the threatened Atlantic saltmarsh snake, are the primary species affected by marsh management.

The Scotsmoor impoundments are herbaceous salt marsh, with freshwater aquatics. These marshes, as well as some in the Turnbull area are proposed for purchase by the St. Johns Water Management District and CARL. The SJRWMD is funding culvert installation in the Shiloh impoundments to control cattails and Brevard County is working with several private owners of the Scotsmoor Impoundments to engage in an innovative management plan that features a cyclic rotational impoundment management-waterfowl management plan.

Merritt Island National Wildlife Refuge manages its impoundments for several objectives including optimizing habitat for natural salt marsh, for wading birds, for overwintering waterfowl, or other wildlife benefits including fisheries.

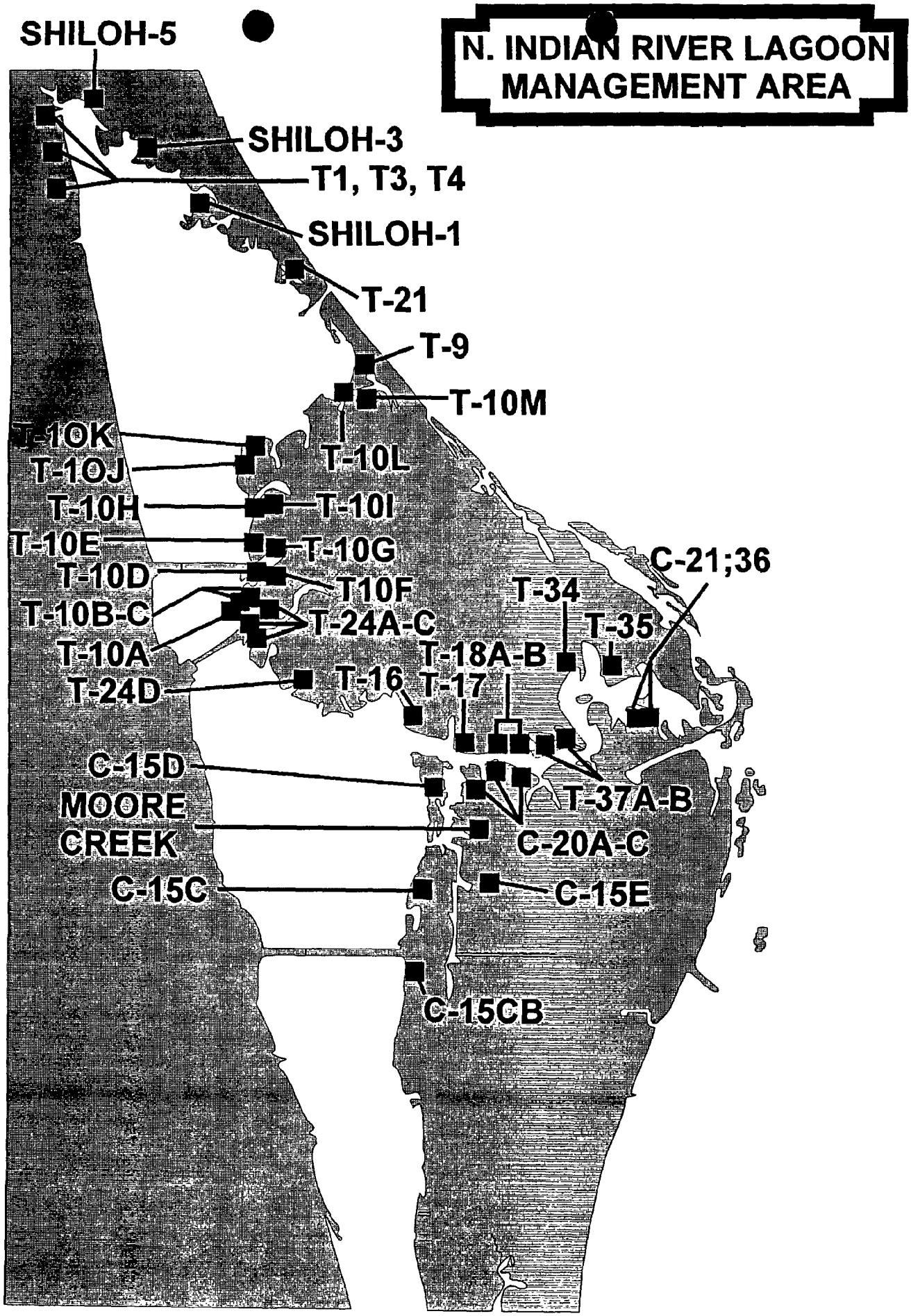
Table 4. Brevard County Impoundments within the N. Indian River Lagoon Management Area

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
SHILOH - 1	273.9	F/W DRAWDOWN- OPEN
SHILOH - 3	132.8	F/W DRAWDOWN - OPEN
SHILOH - 5	205.3	F/W DRAWDOWN - OPEN
T1 - SCOTSMOOR	33.6	RIM - WINTER FLOODING
T3 - SCOTSMOOR	33.6	CYCLIC
T4 - SCOTSMOOR	47.4	CYCLIC

Table 5. MINWR Impoundments within the N. Indian River Lagoon Management Area.

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
MOORE CREEK	181.4	F/W DRAWDOWN - OPEN
C-21;36	381.5	ELEVATED WATER LEVELS
C-20A	605.5	F/W DRAWDOWN - OPEN
C-20B	88.7	F/W DRAWDOWN - OPEN
C-20C	129.6	F/W DRAWDOWN - OPEN
C-15C	541.5	F/W DRAWDOWN - OPEN
C-15CB	349.1	F/W DRAWDOWN - OPEN
C-15D	191.6	F/W DRAWDOWN - OPEN
C-15E	106.5	F/W DRAWDOWN - OPEN
T-37A	15.4	F/W DRAWDOWN - OPEN
T-37B	20.7	F/W DRAWDOWN - OPEN
T-35	23.9	UNMANAGED
T-34	51.8	UNMANAGED
T-24A	48.2	F/W DRAWDOWN - OPEN
T-24B	89.9	F/W DRAWDOWN - OPEN
T-24C	70.9	F/W DRAWDOWN - OPEN
T-24D	1208.9	F/W DRAWDOWN - OPEN
T-21	37.3	F/W DRAWDOWN - OPEN
T-18A	89.5	F/W DRAWDOWN - OPEN
T-18B	62.8	F/W DRAWDOWN - OPEN
T-17	311.9	F/W DRAWDOWN - OPEN
T-16	390.8	F/W DRAWDOWN - OPEN
T-10A	27.1	F/W DRAWDOWN - OPEN
T-10B	17.8	F/W DRAWDOWN - OPEN
T-10C	23.5	F/W DRAWDOWN - OPEN
T-10D	67.6	F/W DRAWDOWN - OPEN
T-10E	23.5	F/W DRAWDOWN - OPEN
T-10F	50.6	F/W DRAWDOWN - OPEN

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
T-10G	54.3	F/W DRAWDOWN - OPEN
T-10H	136.1	OPEN/DITCHED
T-10I	154.3	F/W DRAWDOWN - OPEN
T-10J	234.1	F/W DRAWDOWN - OPEN
T-10K	220.7	DIKE REMOVED
T-10L	270.1	F/W DRAWDOWN - OPEN
T-10M	222.7	F/W DRAWDOWN - OPEN
T-9	72.9	CLOSED


N. INDIAN RIVER LAGOON
MANAGEMENT AREA
SHILOH-5
SHILOH-3
T1, T3, T4
SHILOH-1
T-21
T-9
T-10M
T-10K
T-10L
T-10J
T-10H
T-10I
T-10E
T-10G
T-10D
T10F
T-10B-C
T-24A-C
T-10A
T-24D
T-16
T-17
T-34
T-35
C-21;36
T-18A-B
C-15D
MOORE
CREEK
C-15C
T-37A-B
C-20A-C
C-15E
C-15CB

BANANA RIVER MANAGEMENT AREA

This area covers the Banana River in the northern Indian River Lagoon. It contains 10 impoundments covering 2578 acres in Brevard County, and 14 impoundments covering 1411 acres in the MINWR. A majority of the impoundments outside of MINWR are privately owned except C2 (county) and C3 and C34 (state).

BREVARD COUNTY COMPONENT OF THE BANANA RIVER MANAGEMENT AREA.

ImpoundmentS C2 and C34 are under RIM management, with experimental water level manipulations for wood storks taking place in the south cell of C2. The dikes of impoundments C3, 2, and 10 have been breached, whereas the remaining impoundments are unmanaged. Most of the impoundments in the area have been heavily influenced by fresh water input. A portion of Sykes Creek empties into impoundment C2, and impoundments 1-5, 10, and 11 were formerly flooded by free-flowing wells. The wells have now been capped, and these marshes are now flooded primarily by rainfall.

Vegetation in the impoundments reflects the fresh water influence, with species such as *Typha* spp. and upland exotics dominating many of the areas. Exceptions occur at impoundment C2, which has a significant herbaceous halophyte cover, and C3 and C34, where black mangroves predominate.

Major features of the area include the Sykes Creek Parkway, which runs east of impoundment 1 to the south end of C2, where it connects with Audubon Rd.; the barge canal, SR528, and the 528 Causeway, which divide impoundment C2 into north and south cells; the Central Brevard Airport north of Impoundment 3; the 520 Causeway which crosses the Banana River north of C3; the Cape Canaveral Air Force Station; and the Kennedy Space Center at the northern limit of the management area. Part of Sykes Creek, empties into Impoundment C2, and Newfound Harbor divides the southern tip of Merritt Island into eastern and western halves, with land connections via the 520 Causeway, Sykes Creek Pkwy, and SR528.

Most of this area has been intensively developed except for some areas south of SR528, where approximately 50 ha of Batis-Salicornia marshes exists, and in the 1000-island area, near C34, where mangrove and herbaceous halophyte wetlands exists, mostly in islands within the Banana River.

MINWR COMPONENT OF THE BANANA RIVER MANAGEMENT AREA.

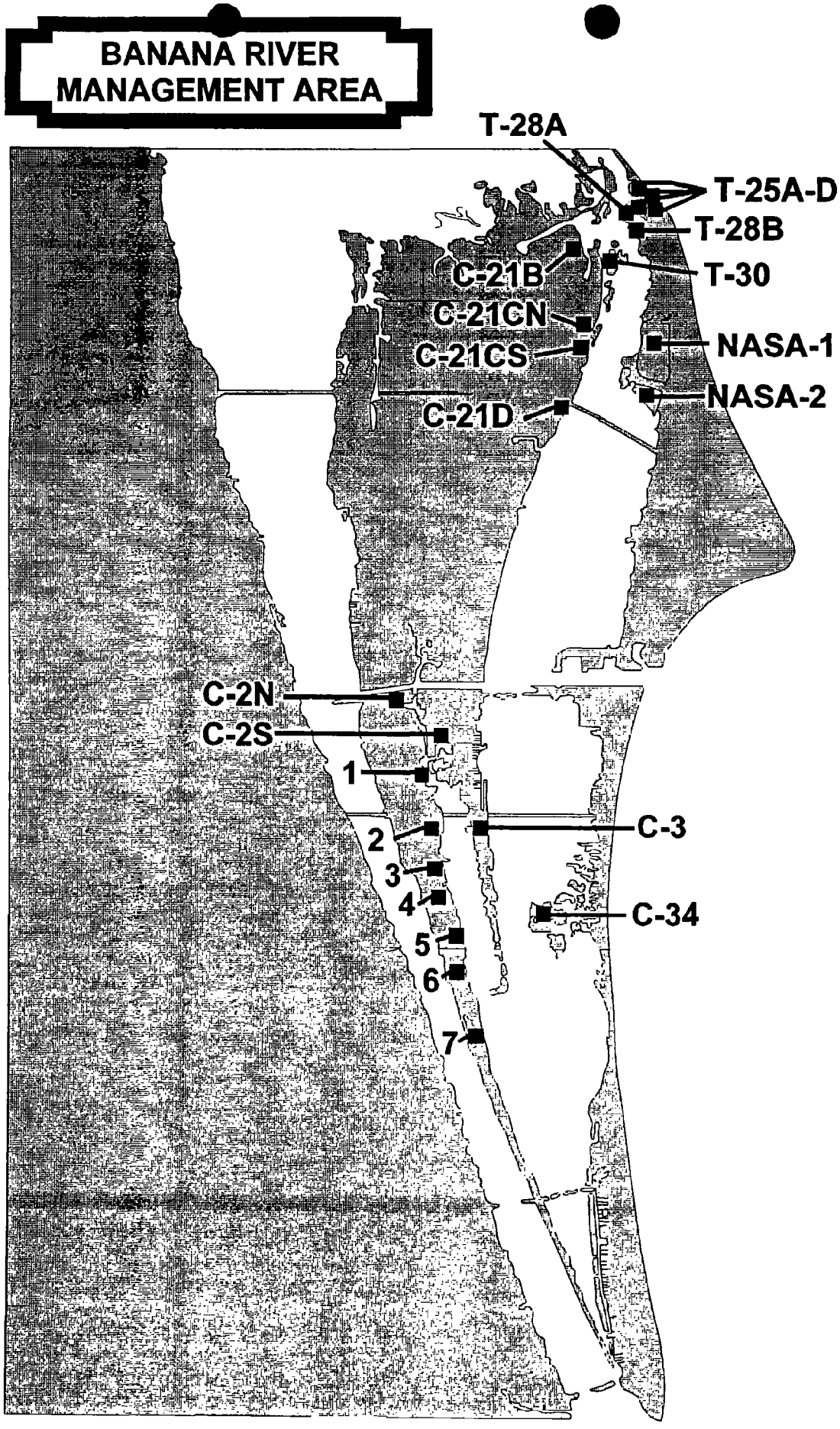
There are 14 impoundments within the MINWR covering 1411 acres (impoundments T-25B and T-25D are joined and listed as one). The T-28 impoundments are presently managed under RIM or under MINWR strategy 2, but could be managed differently if more culverts were available. Impoundments in the C-21 group are now closed all year and are being considered as potential dredge spoil sites. The T-25 group is being managed under MINWR strategies 1 or 2.

Table 6. Brevard County Impoundments within the Banana River Management Area.

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
C2 - SYKES CREEK	851.7	RIM - WOOD STORK
1	10.9	UNMANAGED
2	3.6	BREACHED
3 - S. MERRITT ISLAND A	62.8	UNMANAGED
4 - S. MERRITT ISLAND B	20.7	UNMANAGED
5 - S. MERRITT ISLAND C	36.0	UNMANAGED
10 - TWO OAKS	9.3	BREACHED
11	3.2	FILLED
C3	12.6	BREACHED
C34 - GUMBO LIMBO ISLAND	33.2	RIM

Table 7. MINWR Impoundments within the Banana River Management Area.

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
T-25A	140.5	MINWR STRATEGY 1, 2
T-25B,D	87.9	MINWR STRATEGY 1, 2
T-25C	27.1	MINWR STRATEGY 1, 2
T-28A	11.8	RIM MINWR STRATEGY 2
T-28B	70.9	RIM MINWR STRATEGY 2
T-30	34.4	CLOSED
C-21B	101.3	CLOSED
C-21C	19.9	CLOSED
C-21D	6.1	CLOSED
C-22A	19.0	UNMANAGED
C-22B	19.0	UNMANAGED
C-22C	9.3	UNMANAGED
C-22D	12.2	UNMANAGED
C-22E	12.2	UNMANAGED


BANANA RIVER
MANAGEMENT AREA
T-28A
T-25A-D
T-28B
T-30
C-21B
C-21CN
C-21CS
C-21D
NASA-1
NASA-2
C-2N
C-2S
1
2
3
4
5
6
7
C-3
C-34

SEBASTIAN INLET MANAGEMENT AREA

The Sebastian Inlet Management Area extends from State Road 510 the Wabasso Causeway and bridge) in Indian River County northward to Hog Point in Brevard County. This north south distance is about 16 miles and includes all the salt marshes, mangrove swamps and impoundments on the barrier Island side of the Indian River Lagoon. There are many mangrove islands included in the management area. The western boundary is the Intracoastal Waterway. Most of the public and private lands have had individual impoundment management plans developed in the last three years since development of the Sebastian Inlet Management Area Regional Plan.

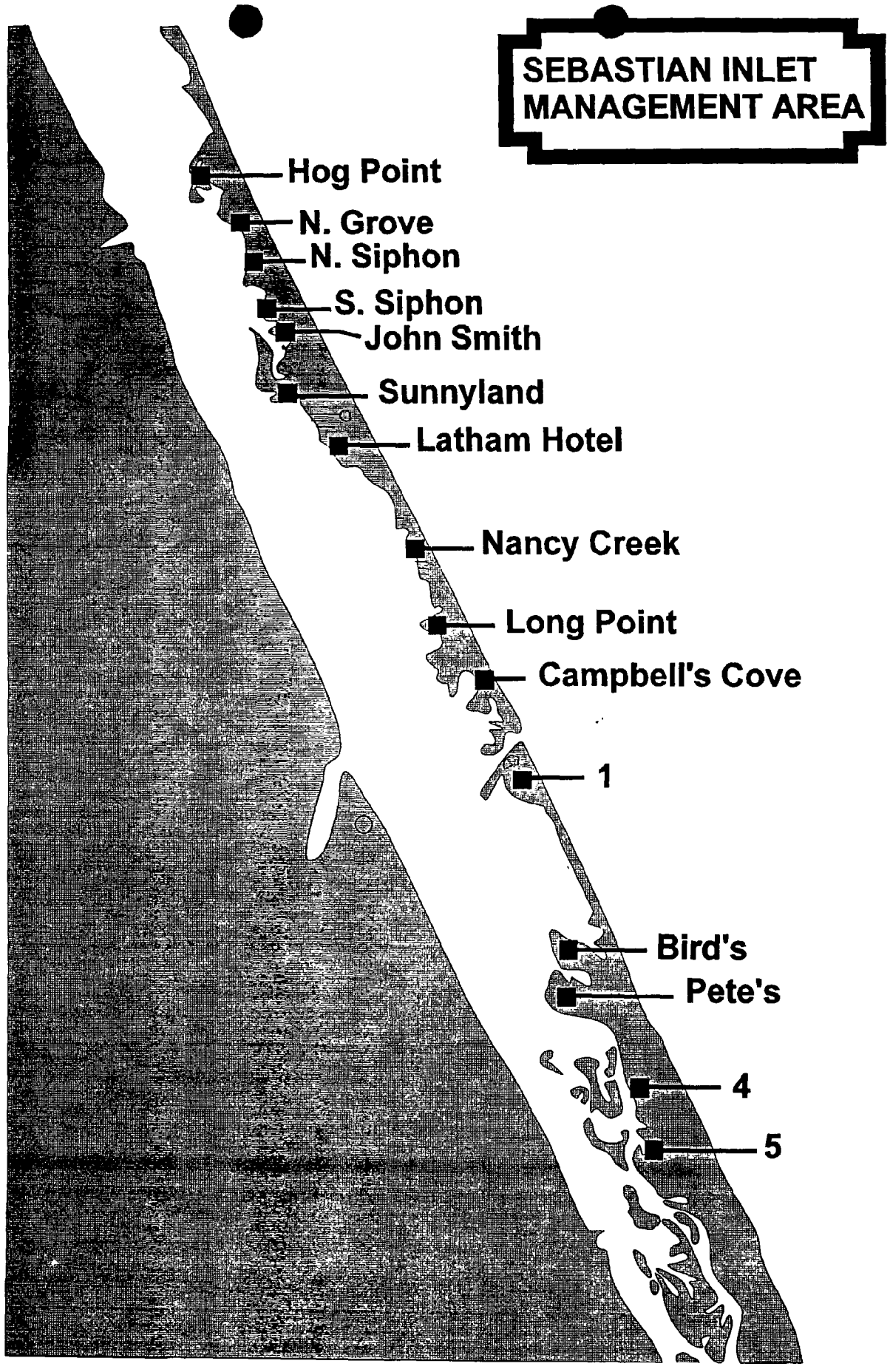
The major features of this area are the Sebastian Inlet and the St. Sebastian River, a freshwater source west of the area. The proximity of the inlet to all these marshes is important, especially for fishery options related to the abundant supply of organisms entering the Indian River Lagoon at this location.

There are two important wading bird rookeries in or near the Management Area; Pelican Island and Grant Farm Island. Both of these rookeries support the endangered wood stork as well as other colonial nesting wading birds. Pelican Island is the central focus of Pelican Island National Wildlife Refuge, administered by the Fish and Wildlife Service. Other publicly owned areas of importance are the Sebastian Inlet State Park, and Long Point county park.

There are 15 impoundments in the SIMA, two of which are breached and unmanaged. The total impoundment area in the SIMA is 1206 acres (488.5 ha). Most of these impoundments are in Rotational Impoundment Management, and the two nearest two Pelican Island have a special winter pump up and drawdown feature for wading bird feeding. About 340 acres (137.7 ha) of island marshes and mangrove swamps which are unimpounded, but most of these islands have been ditched in the past.

Table 8. Impoundments within the Sebastian Inlet Management Area

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
HOG POINT	42.9	UNMANAGED
NORTH GROVE	23.1	SEASONALLY FLOODED
NORTH SIPHON	3.2	UNMANAGED
JOHN SMITH	63.6	RIM
SOUTH SIPHON	6.5	UNMANAGED
SUNNYLAND	24.3	SEASONALLY FLOODED
LATHAM HOTEL	10.9	UNMANAGED
NANCY CREEK	6.9	SEASONALLY FLOODED
LONG POINT	60.8	RIM
CAMPBELL'S COVE	27.5	RIM
1 - INLET	62.0	RIM
2- BIRD'S	63.1	RIM
3 - PETE'S	60.8	RIM
4 - NORTH DEERFIELD	20.7	UNMANAGED
5 - SOUTH DEERFIELD	12.2	UNMANAGED


SEBASTIAN INLET
MANAGEMENT AREA
Hog Point
N. Grove
N. Siphon
S. Siphon
John Smith
Sunnyland
Latham Hotel
Nancy Creek
Long Point
Campbell's Cove
1
Bird's
Pete's
4
5

WINTER BEACH MANAGEMENT AREA

The WBMA lies in Indian River County beginning 4.5 miles south of the Sebastian Inlet and extends south for approx. 9 miles. This management area include marshes on both the eastern and western shores of the Indian River lagoon (IRL) and islands within it. There are 17 impoundments in the WBMA, with all of the impoundments (except #22), and much of the open marsh being privately owned.

NOTABLE FEATURES WITHIN WBMA. The fact that most of the MLMA marshes are privately owned has limited optimal management opportunities for this area. Development along the southern portion of the WBMA is considerable. Most of the marsh property is impounded with several of the impoundments under RIM management. Located near this management area's northern end is the Wabasso (CR 510) Causeway which to some extent restricts water movement. The WBMA includes the area of the IRL commonly referred to as the "Narrows" which is roughly equidistant from the Sebastian and Ft. Pierce Inlets and receives little or no oceanic flushing. The Main Relief Canal (at the southern end of WBMA) and the North Relief Canal (also near the southern end of WBMA and just north of the Grand Harbor Development) is within this management area which provides periodic pulses of freshwater from upland runoff.

Vegetation in impoundments within WBMA differ considerably among marshes. In some impoundments, *Avicennia germinans* (black mangrove), *Rhizophora mangle* (red mangrove), *Laguncularia racemosa* (white mangrove), or a combination of these dominate, while in others *Batis maritima*, *Salicornia spp.*, or *Distichlis spicata* dominate. *Distichlis spicata* occurs significantly only in a few mainland impoundments in the "Narrows". The Pelican Island National Wildlife Refuge (with an associated rookery) is nearby the northern end of the WBMA. Bird utilization of WBMA marshes is undoubtedly influenced by this close proximity to Pelican Island.

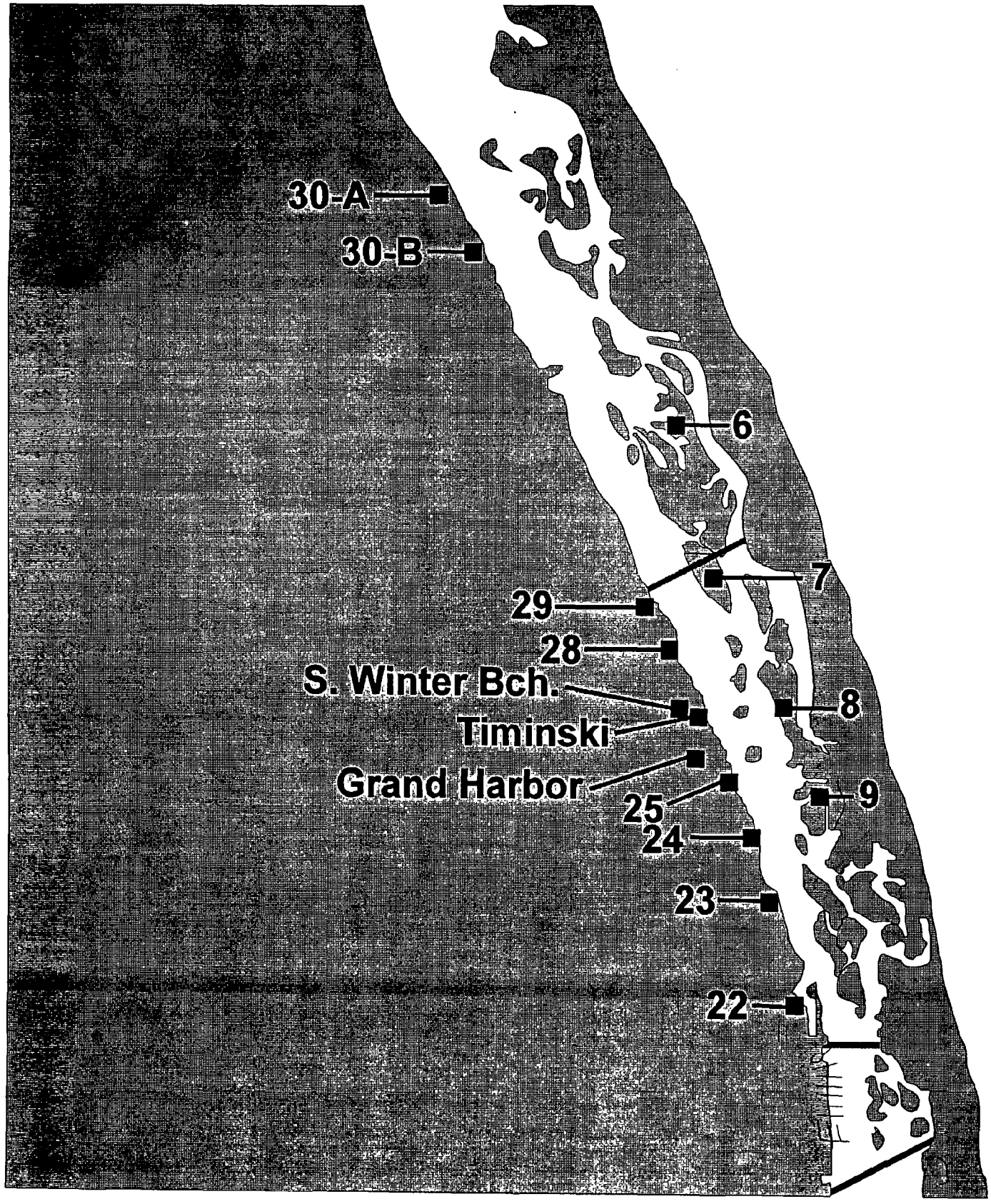
IMPOUNDMENTS. The 17 WBMA impoundments total 1452 acres and are currently managed in a variety of ways including: 1) Rotational Impoundment Management (RIM), 2) open through culverts, 3) breached, 4) Open Marsh Water Management (OMWM) with rotary ditches, 5) and flooded year-round.

UNIMPOUNDED MARSHES. The unimpounded marshes within WBMA include mostly previously ditched marshes along the IRL fringe and islands within the lagoon. These marshes total approx. 250 acres which greatly contribute to the salt marsh diversity of this Management Area. The largest of these unimpounded marshes are at the southern end of IRC Impoundment #6 (Pine Island) and a marsh just south of Quay Dock Rd. in Winter Beach proper.

Table 9. Impoundments within the Winter Beach Management Area.

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
#30A - VICKERS	18.3	FLOODED YEAR-ROUND
#30B - S. VICKERS	6.5	OPEN WITH 4 CULVERTS
#29 - MORGANS	28.8	SUMMER FLOODING
#6 - PINE ISLAND	129.6	RIM
#7 - HOLE IN WALL	52.7	RIM
#28 - N. WINTER BEACH	29.2	SUMMER FLOODING (RIM PLAN IN DEV.)
#27 - S. WINTER BEACH	12.2	OPEN WITH 1 CULVERT OCCASIONAL LARVICIDING
#27S - TIMINSKY	19.0	OPEN THROUGH #27 OCCASIONAL LARVICIDING
JOHNS ISLAND	14.2	BREACHED IMPOUNDMENT OCCASIONAL LARVICIDING
#8 - WATER TOWER	61.6	SUMMER FLOODING
#9 - SAND POINT	60.3	SUMMER FLOODING
GRAND HARBOR	41.3	OMWM
#26 - TRIANGLE	6.5	OMWM
#25 - GIFFORD PLOTS	30.8	BREACHED FREQUENT LARVICIDING
#24 - N. JOHN KNIGHT	23.1	BREACHED FREQUENT LARVICIDING
#23 - S. JOHN KNIGHT	17.8	ISOLATED FREQUENT LARVICIDING
#22 - GOLF COURSE	36.5	RIM

WINTER BEACH MANAGEMENT AREA



OSLO MANAGEMENT AREA

The Oslo Management Area's (OMA) northern boundary is located at the 17th Street Bridge in Indian River County (IRC) and extends south for approximately 11.5 miles to the northern portion of St. Lucie County (SLC). OMA includes marshes on both the eastern and western shores of the Indian River Lagoon (IRL), and islands within the lagoon. 22 impoundments occur in this Management Area. While most of these impoundments are privately owned, 2 are publicly owned with at least 2 more currently under serious consideration for public purchase.

NOTABLE FEATURES WITHIN OMA. As is the case with many of the 10 Management Areas, the fact that many of the OMA marshes are privately owned has limited optimal management opportunities in this area. Most of the marsh property is impounded with several of the impoundments under RIM management. The southern end of the OMA is near the Ft. Pierce Inlet which provides good oceanic water exchange especially for the St. Lucie County impoundments in the southern end of OMA. IRC's South Relief Canal (near the northern end of OMA) provides periodic freshwater pulses to the IRL.

IRC Impoundment #12 (located on the barrier island at the IRC/SLC border) and SLC Impoundments #23 & 24 served as study sites for the series of Coastal Zone Management studies during the 1980's which studied ecosystem effects of impoundment management practices. This research demonstrated the scientific validity of Rotational Impoundment Management (RIM) as a viable impoundment management technique providing source reduction mosquito control with natural resource benefits.

It is noteworthy that a joint purchase of 300 acres on the mainland side of the lagoon in and around IRC Impoundment #18 (Vista Royale) by IRC and the St. Johns River Water Management District is playing an important role in preserving and improving management of these resources which include an oak hammock, scrub hammock, tidal and impounded wetlands. A grant awarded by the Florida Inland Navigation District (FIND) will allow development of the educational opportunities for this area which is being called the "Oslo Riverfront Park".

Several miles south of Oslo Road in SLC, occurs several marshes which receive a considerable fresh water input from the uplands, in particular the sand ridge. Also along the west side of US 1 lies the "Savannahs", a freshwater habitat targeted for public acquisition.

On the eastern edge of the lagoon in SLC Impoundment #23 (which is State owned) abuts a large oak-palmetto hammock with considerable encroachment by exotic vegetation in particular Brazilian pepper (*Schinus terebinthifolius*). Several miles south of this lies Impoundment #19B which includes a fairly intact tropical hammock.

Vegetation in OMA impoundments differ considerably among marshes. In some impoundments, *Avicennia germinans* (black mangrove), *Rhizophora mangle* (red mangrove), *Laguncularia racemosa* (white mangrove), or a combination of these dominate, while in some other marshes, *Batis maritima*, or *Salicornia spp.* dominate. Several rookeries influence bird use in OMA. One is adjacent (but just outside) OMA to the north, the other is a spoil island off Oslo Road, the third within IRC Impoundment #13.

INDIAN RIVER COUNTY COMPONENT OF THE OMA. In IRC, OMA includes 13 impoundments totalling 779 acres with only Impoundment #17 (=133 acres) being publicly owned. Also included are approximately 150 acres of unimpounded marsh divided among the lagoon fringes and islands within the IRL.

IMPOUNDMENTS. The 13 OMA impoundments in IRC are currently managed in a variety of ways including: 1) Rotational Impoundment Management (RIM), 2) summer flooding only, 3) breached with larvicide treatments as necessary, 4) connected to the lagoon through culverts, 5) year-round flooding, 6) receiving secondarily treated wastewater (the only example we are aware of along the IRL; the possible impacts of this practice are unclear).

UNIMPOUNDED MARSHES. The unimpounded IRC marshes within OMA include marshes fringing the lagoon and several islands. The largest unimpounded marsh is where the South Relief Canal enters the IRL.

ST. LUCIE COUNTY COMPONENT OF OMA.

IMPOUNDMENTS. Impoundments 23, 24, 19B, 19D, and 21 are primarily estuarine systems managed in a variety of ways, including RIM, tidal trapping, or breached. Larviciding is done frequently, especially in impoundments 23 and 24. Impoundments 23 and 24 are frequently used by wading birds, and 19B is very alluring to wading birds during summer drawdowns. These impoundments contain large stands of mangroves and saltwort.

Impoundments 14A, 14B, and 14C are basically fresh water systems with little or no connection to the lagoon. These marshes maintain a variety of fresh water fauna and flora, and provide forage and resting areas for mottled ducks, blue-wing teal, and a variety of wading birds. Water is provided to these marshes via rainfall, or by runoff and seepage from the coastal ridge system

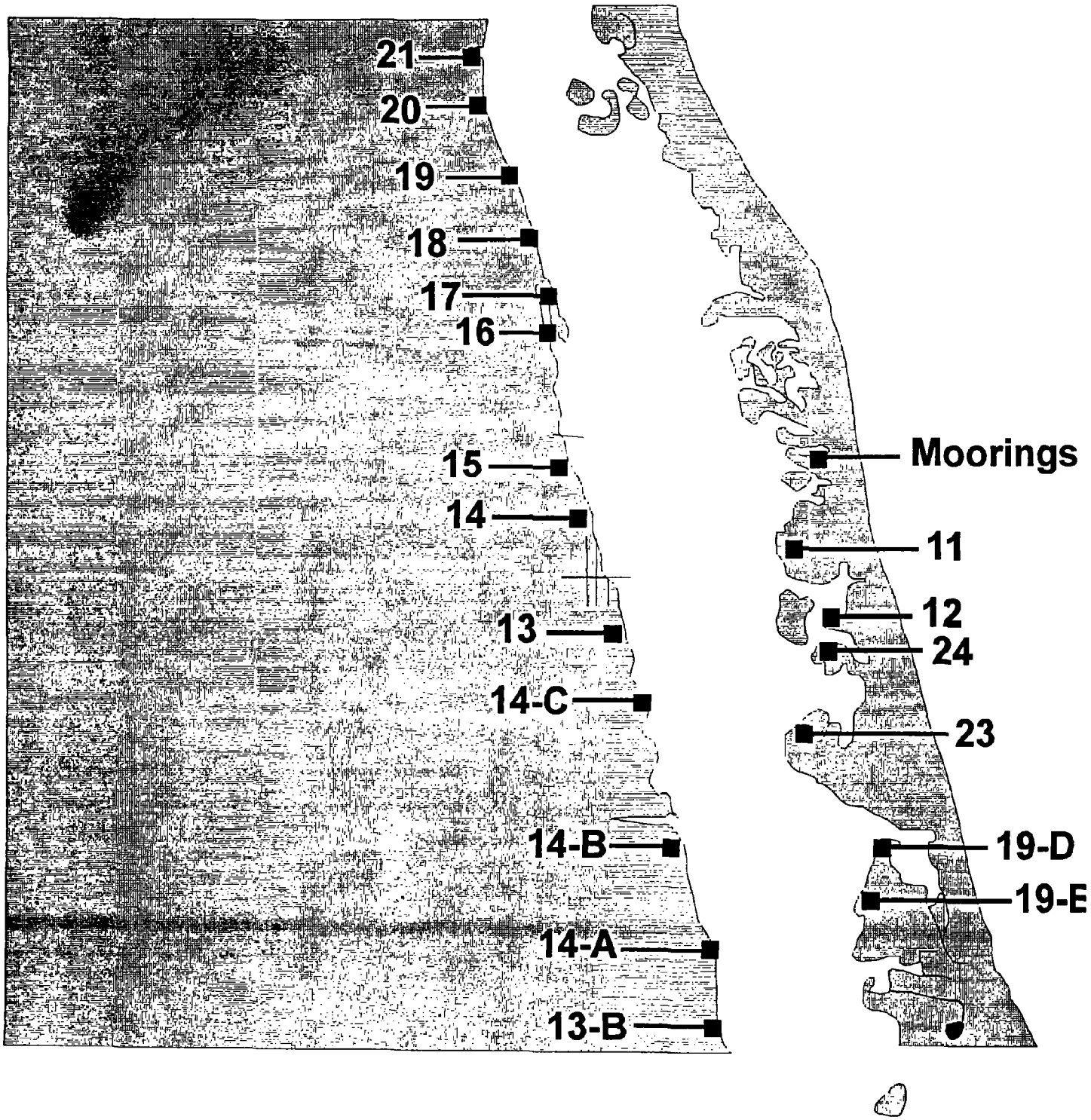
immediately to the west. A nearly pristine coastal hammock lies to the west of impoundment 14C.

Table 10. Impoundments within the Oslo Management Area. IRC = Indian River County, SLC = St. Lucie County.

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
#21 - SCHLITTS (IRC)	14.2	SUMMER FLOODING
#20 - JUNGLE GARDENS (IRC)	35.2	SUMMER FLOODING
#19 - N.VISTA ROYALE (IRC)	21.1	RECEIVES TREATED WASTEWATER
#18 - SOUTH VISTA ROYALE (IRC)	53.9	RIM PLAN UNDER DEVELOPMENT
#17 - LOWENSTEIN (IRC)	26.3	BREACHED/FREQUENT LARVICIDING
#16 - N. BILLS (IRC)	16.2	RIM (CONNECTED TO #15)
#15 - MIDDLE BILLS (IRC)	18.6	RIM (CONNECTED TO #15 & #16)
#14 - S. BILLS (IRC)	12.2	RIM (CONNECTED TO #15
#13 - VERO SHORES (IRC)	14.2	SUMMER FLOODING
#10A - N. MOORINGS (IRC)	12.2	YEAR-ROUND FLOODING
#10B - S. MOORINGS (IRC)	4.1	BREACHED
#11 - OYSTER BAR (IRC)	66.4	SUMMER FLOODING OCCASIONAL LARVICIDING
#12 - COUNTY LINE (IRC)	21.1	OPEN WITH CULVERTS OCCASIONAL LARVICIDING
#24 (SLC)	36.5	OPEN WITH CULVERTS
#23 (SLC)	121.9	BREACHED FREQUENT LARVICIDING
#21 (SLC)	27.1	BREACHED OCCASIONAL LARVICIDING
#19D (SLC)	2.8	BREACHED

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
#19B (SLC)	106.9	RIM
#14C (SLC)	77.0	UNMANAGED
#14B (SLC)	13.8	UNMANAGED
#14A (SLC)	17.0	UNMANAGED
#13B (SLC)	16.6	UNMANAGED

OSLO MANAGEMENT AREA



FT PIERCE INLET MANAGEMENT AREA

The Ft. Pierce Inlet (FPI) Management Area (FPIMA) includes several large mosquito impoundments which are presently under management (St. Lucie County Impoundment numbers 19A, 16A, 17A, 18A, 1, 2, 3, 4, 5, and 6) and several smaller impoundments which are not presently managed. Dominant terrestrial vegetation types are mangroves interlaced with areas of saltwort and mudflats. A majority of the mangroves were killed or severely damaged in the freeze of December 1989 but juvenile plants are rapidly recolonizing these areas. A very diverse tropical hammock exists on Impoundment 19B, adjacent to the FPIMA. Exotic plants (*Schinus terebinthifolius* and *Casuarina* sp.) have colonized many of the dikes and some of the upland areas in this management area. Most impoundments have multiple culverts which aid in tidal exchange between the impoundments and the surrounding Indian River during unmanaged periods. This management area also contains several large mangrove islands (some up to several acres in size) which have never been modified for mosquito control and remain in a pristine state.

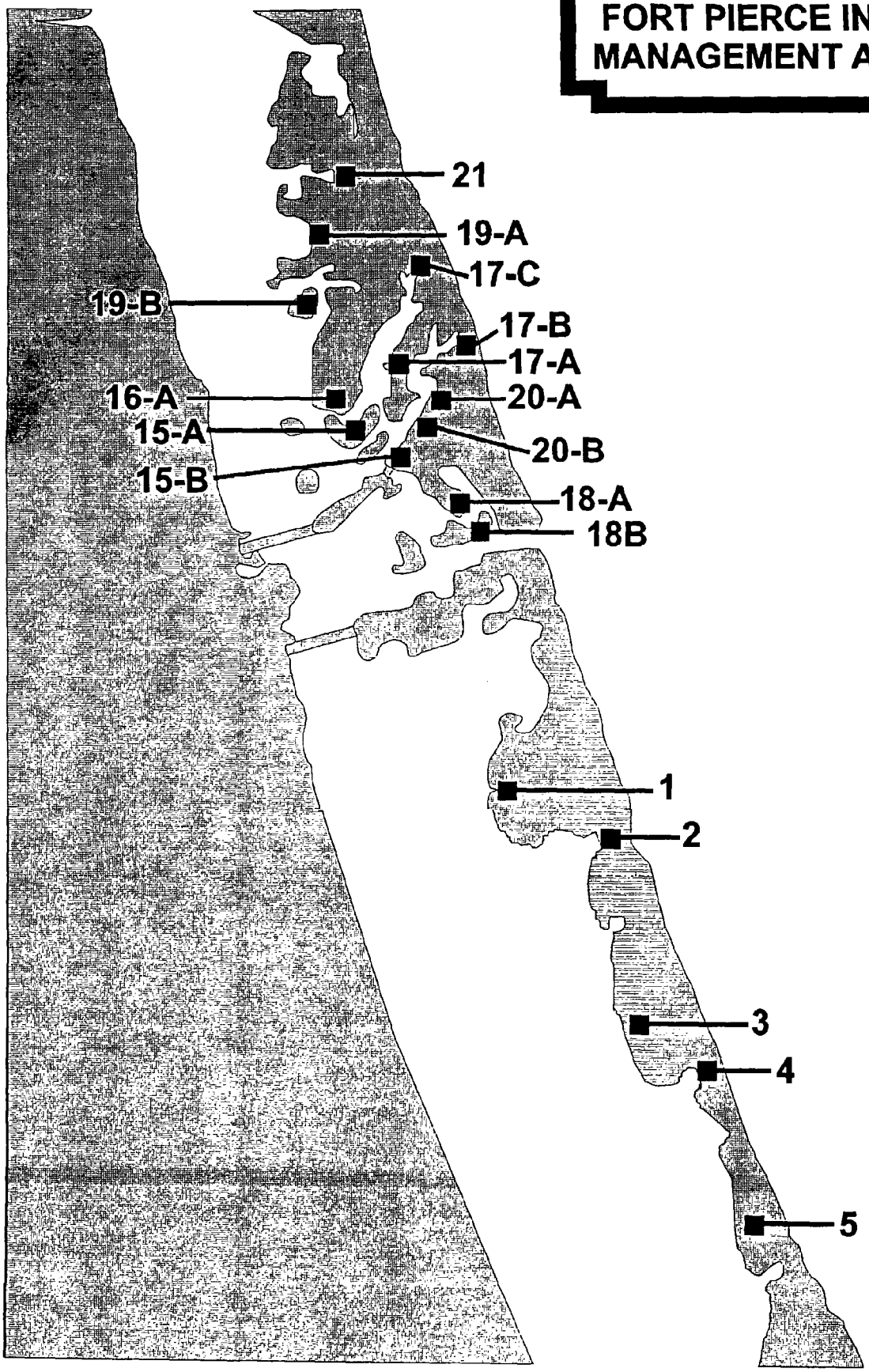
The Ft. Pierce Management area is transected by the Ft. Pierce Inlet. Because of the presence of the inlet, lagoonal salinities and temperatures tend to remain more constant than in areas more distant from the inlet. The less saltatory salinity and temperature regimes of the area coupled with the high species diversity of the inlet tend to give this management area a relatively high diversity of estuarine fauna. Dense seagrass beds in the Indian River, and tidal creeks and canals in the mosquito impoundments support a wide variety of marine life including tarpon, redfish and manatees. Many species of birds, reptiles and mammals occur throughout the area. The beaches on the ocean side of this management area serve as nesting sites for sea turtles.

The Ft. Pierce Management Area contains considerable urban development adjacent to the Ft. Pierce Inlet and for some distance north and south. Two causeways connect Hutchinson Island with the mainland. Jack Island State Preserve, Pepper Park, The Inlet State Park and John Brooks Park contain publicly owned land in this management area. Presently, St. Lucie County is negotiating for the purchase of an additional 330 acres of wetland adjacent to the John Brooks Park. If the county is successful in acquiring this parcel, about three miles of lagoonal shoreline will be under public ownership south of the inlet. This, in conjunction with the approximately 4 miles of shoreline under public ownership north of the inlet should form a relatively large block of protected wetlands.

Table 11. Impoundments within the Ft. Pierce Inlet Management Area

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
19A	67.6	RIM
19D	2.8	UNMANAGED
21	27.1	UNMANAGED
18A	72.1	RIM LEFT OPEN 1993
18B	6.1	UNMANAGED
17A	48.2	RIM
17B	6.5	UNMANAGED
17C	1.2	UNMANAGED
1	258.8	RIM - MAY BE UNMANAGED IN 1994
2	76.1	RIM
3	68.0	RIM
4	79.4	RIM
5	72.1	RIM
6	142.6	RIM

FORT PIERCE INLET MANAGEMENT AREA



JENSEN BEACH MANAGEMENT AREA

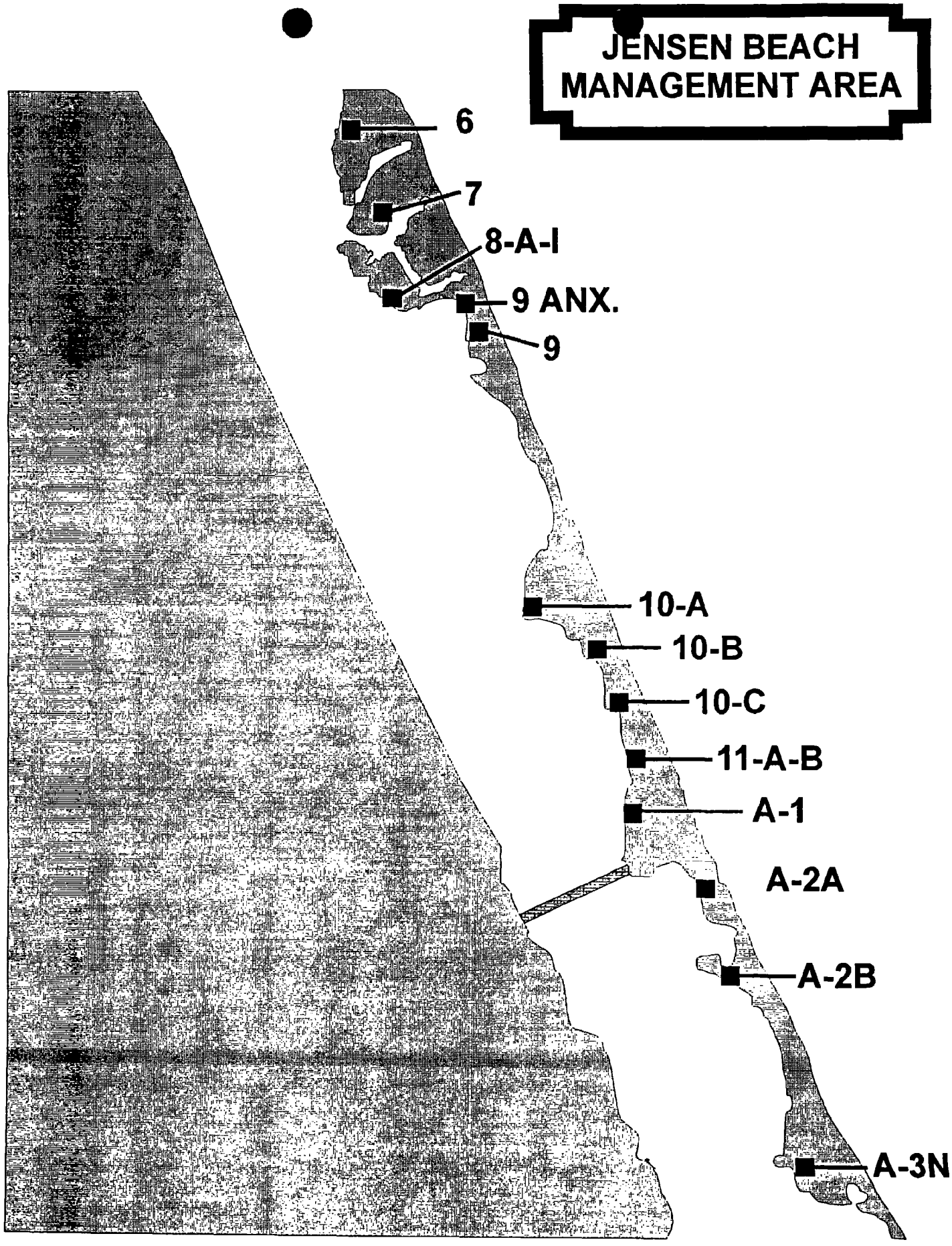
The northern part of the Jensen Beach management area consists of several large managed mosquito impoundments (St. Lucie County impoundments 6, 7, 8A, 8B, 8C, 8E and 9) and three unmanaged marshes (St. Lucie County Impoundments 10A, 10B, and 12 (= Martin County Impoundment 1A). Dominant wetland vegetation consists mainly of mangroves with some large areas (several acres) of saltwort on impoundment 10A. Impoundments 6 and 10A both contain areas of uplands which support both exotic (*Schinus terebinthifolius* and *Casuarina* sp.) and native tropical and sub-tropical hammock vegetation. The 1989 freeze caused extensive damage to many of the mangroves in this management area but many plants have recovered and where mortality occurred, mangrove recruitment is high.

All of the mosquito impoundments in this management area have multiple culverts which increase tidal replication and water interchange with the adjacent Indian River during unmanaged periods. One of the unmanaged impoundments (10A) is breached by a 100 foot channel which allows for open exchange between the estuary and the marsh at all times. The Indian River adjacent to the Jensen Beach management area supports large seagrass beds and a relatively diverse estuarine fauna. The beach areas to the east of the mosquito impoundments serve as nesting areas for sea turtles.

Development impacts are high in this area with a nuclear power plant occupying part of the northern zone of the management area and considerable condominium and commercial development covering large parts of Hutchinson Island south of Impoundment 10A. Also within this area are some travel trailer resorts which have been built on dredge and fill areas in the Indian River. A golf course is located on the uplands on the northern part of Impoundment 10A. Two causeways connect the barrier island with the mainland south of the Martin County Line. A large portion of impoundments 10A and 9 and several public beach access are the only publicly owned land in the St. Lucie County portion of this management area. This property, coupled with the approximately 450 acres of wetland owned by Florida Power and Light are the only major tracts presently under protection from development.

Table 12. Impoundments within the Jensen Beach Management Area. SLC = St Lucie County, MC = Martin County.

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
6	149.6	RIM
7 AND 8A (SLC)	131.6	RIM
8B AND 8C (SLC)	28.8	RIM
8D (SLC)	2.0	OPEN
8E (SLC)	19.4	MANAGED BY FP&L FOR TREES
8F (SLC)	0.8	OPEN
8G (SLC)	0.8	UNMANAGED
8H (SLC)	0.8	UNMANAGED
8I (SLC)	0.8	OPEN
9 ANNEX (SLC)	10.5	UNMANAGED
9 (SLC)	41.7	RIM
10A (SLC)	111.4	40 ACRES MANAGED
10B (SLC)	35.2	OPEN
10C (SLC)	0.8	OPEN
11A (SLC)	4.1	OPEN
11B (SLC)	6.1	OPEN
12 (SLC) A1 (MC)	68.9	OPEN
A2A (MC)	10.9	BREACHED
A2B (MC)	23.1	BREACHED
A3N (MC)	30.8	RIM


JENSEN BEACH
MANAGEMENT AREA
6
7
8-A-I
9 ANX.
9
10-A
10-B
10-C
11-A-B
A-1
A-2A
A-2B
A-3N

ST. LUCIE INLET MANAGEMENT AREA

The St. Lucie Inlet Management Area (SLIMA) extends from the Stuart Causeway in the North, to south of impoundment G2 in Martin County. It contains four impoundments with a combined area of 295 acres. Impoundments E3, E5, and G2 are on the mainland side of the lagoon, whereas A3s is on the barrier island side. None of the impoundments are actively managed, and the dikes of E3, E5, and G2 are breached. The impoundment vegetation consists mostly of mixed mangroves, with some upland species and exotics occupying some of the higher marsh areas.

NOTABLE FEATURES WITHIN THE SLIMA. Major features of this area include the St. Lucie Inlet, the Stuart Causeway, SR707 (Bridge Rd.), USA1A, and the mouth of the St. Lucie River. The Jupiter Inlet is south of the management area. Except for public lands, the area along A1A is heavily developed, with a mixture of condominiums and single-family developments (both permanent and seasonal residents) and small businesses. The mainland side contains mostly single-family homes and small businesses

The St. Lucie Inlet State Park extends south from the inlet along the barrier island to Cove Rd., near Peck Lake, where it adjoins the Hobe Sound National Wildlife Refuge (HSNWR). The area around Peck Lake contains some natural marshes on the east side, whereas the west was formerly impounded, but has slowly reverted to a semi-natural state, with only some remnants of the dike remaining.

There are three unmanaged impoundments within the HSNWR (F1-F3), two of which have breached dikes (F2 & F3). Vegetation is mostly mixed mangroves, and there are no pumps or water control structures associated with these impoundments. The HSNWR also extends south from impoundment G2 (south of Bridge Rd.) on the mainland side with some interspersed residential development. The barrier island side on this part is almost completely developed with upscale single-family homes.

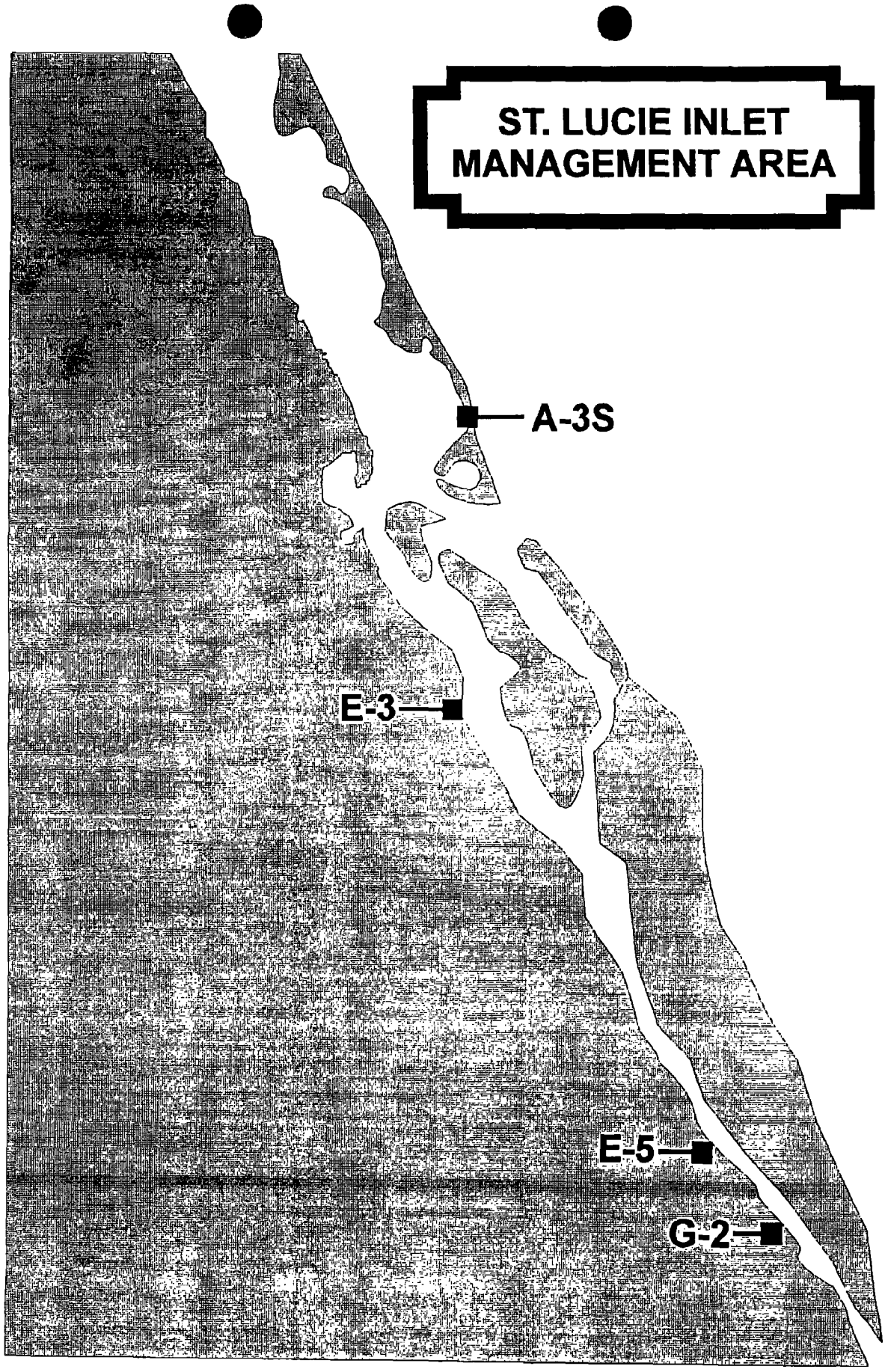
Further south, near the Palm Beach County line on the barrier island is the Blowing Rocks Preserve. This area is operated by the Nature Conservancy as a conservation-educational area. Within the preserve there is an extensive network of old mosquito control ditches that link to Hobe Sound via culverts. Much of the original ditching was along the border of spoil piles created by the construction of the Intracoastal Waterway. These piles have been colonized by *Casuarina*, and needle fall has filled some of the ditches. During the 1970's, an attempt was made to reconnect some of the ditches that were closed off by shoreline drift, but

appropriate depths for ditches and culverts could not be attained because in this area, the Anastasia limestone is very close to the surface. As a result, the system has closed again. Within the Preserve, the area east of A1A was effectively impounded by the construction of A1A and the Intracoastal Waterway.

There has been recent pressure by surrounding residents for some measure of mosquito control in the area. Both the Nature Conservancy and Martin County Mosquito Control desire to undertake renovation of the dormant, unmanaged system to provide environmental enhancement and effective mosquito control.

Table 13. Impoundments within the St. Lucie Inlet Management Area.

IMPOUNDMENT	SIZE	CURRENT MANAGEMENT
A3S	6.1	UNMANAGED FREQUENT LARVICIDING
E3	93.6	UNMANAGED FREQUENT LARVICIDING
E5	4.5	UNMANAGED TREATMENT VARIES
G2	15.4	UNMANAGED TREATMENT VARIES
F1		UNMANAGED TREATMENT VARIES
F2		UNMANAGED TREATMENT VARIES
F3		UNMANAGED TREATMENT VARIES


ST. LUCIE INLET
MANAGEMENT AREA
A-3S
E-3
E-5
G-2

E. MANAGEMENT STRATEGIES

This section describes management strategies most likely to be used in marshes along the lagoon. The list is by no means exhaustive, and the techniques described are subject to considerable modification to accommodate different marsh structures and management goals. Major alternatives from each category are described in the remainder of this section.

MANAGEMENT STRATEGIES

I. UNMODIFIED

A. Managed (larvicided)

B. Unmanaged

II. MODIFIED

A. Impounded

1. Closed
2. Open
3. RIM
4. Seasonal
   a. summer drawdown
   b. fall/winter drawdown
   c. winter flooding/spring drawdown
   d. pre-summer drawdown
5. Cyclic
6. OMWM
7. Continuous Bleed
8. Other

B. Unimpounded

1. OMWM
2. Ditched
3. Other

(I.A) UNMODIFIED MANAGED

Marshes under this category have not been impounded or ditched. Mosquito control is achieved by using larvicides when breeding becomes a problem.

(I.B) UNMODIFIED UNMANAGED

These are unmodified wetlands where no larvicides are used for mosquito control.

(II.A.1) CLOSED SYSTEMS

A closed impoundment is one which is not connected to the adjacent estuary at any time during the year. Impoundments maintained in this fashion may be actively flooded via pumps or wells, or passively flooded by trapping rainfall or stormwater runoff. Impoundments may be flooded year-round, or only seasonally.

Impoundment cells can be managed on a continuous flooding basis to provide suitable conditions for growth of waterfowl food plants and for feeding of resident and overwintering waterfowl. Although continuous flooding is not necessary to promote waterfowl utilization (see "Seasonal Drawdown"), the technique may be used when there are no provisions for draining down the impoundment (no culverts), or when flooding must be maintained throughout the year for other reasons (e.g. for stormwater retention).

For best results for waterfowl, impoundments are flooded with 12 to 24 inches of water. Moderate salinities (about 10 ppt) are desirable but not imperative to grow *Chara* the primary waterfowl food plant. Depending upon the amount of freshwater inflow, the impoundment can be pumped-up with Indian River Lagoon water as needed to maintain desirable water levels and eliminate weeds.

Advantages:

1) If the marsh is kept flooded, salt marsh mosquito (and sandfly) production from that site is eliminated year-round with no need for larviciding.

2) If proper salinities can be maintained, the marsh may be managed for waterfowl habitat.

3) Conducive to development of large populations of resident fish.

Disadvantages:

1) Many of the natural marsh functions are eliminated.

2) Not having any estuarine connection, means that benefits provided by the late summer/early fall rise in sea level that normally penetrate a marsh are eliminated.

3) Biodiversity is reduced.

4) May adversely affect marsh vegetation.

5) Precludes the use of other management techniques.

6) Long term maintenance of a closed system may degrade waterfowl habitat.

(II.A.2) OPEN SYSTEMS WITH NO HYDROLOGICAL MANAGEMENT

An open impoundment is one where a connection to the adjacent estuary is maintained year-round through breaches in the dike or through open culverts. By definition, open systems interfere the least with the natural pathways of material, energy, and organism exchange between wetlands and the lagoon. Several types of open systems can be envisioned:

1) impoundments with breached dikes
2) impounded marshes where the culverts remain open all year.
3) connections maintained year-round by opening culverts only part way or by restricting spillage over riser boards. This is usually done to manipulate salinity, to control overdrainage of the marsh and/or to control water levels in all or parts of the marsh.

Open systems are best suited for areas where mosquito production is not a major problem such as areas removed from population centers, or in areas where other types of mosquito control can be effective. Open systems may also be appropriate as part of management schemes where management techniques in different members of an impoundment block alternate from year to year.

Advantages:

1) The marsh is able to largely function in a natural fashion.

2) If mosquito production is not a problem, continued management efforts are not required.

Disadvantages:

1) It is impossible to accomplish mosquito source reduction through flooding thus requiring other forms of mosquito control such as OMWM or the application of chemicals as needed (larvicides directly to the marsh and adulticides in nearby areas).

2) Large sand fly populations often develop along the marsh edges and along the edges of creeks.

(II.A.3) ROTATIONAL IMPOUNDMENT MANAGEMENT

Rotational Impoundment Management (RIM) is a technique that provides for source reduction mosquito control and the improvement of fish and wildlife habitat and water quality. It is a working compromise between totally open impoundments, where flooding is not possible, and totally closed impoundments, where many of the natural marsh functions are eliminated. RIM impoundments are minimally flooded from the late spring to early fall to prevent salt-marsh mosquito oviposition while protecting desirable vegetation. The impoundment is left open or partially open to the estuary for the remainder of the year to allow water, nutrient and organism exchange between the impoundment and estuary, and normal marsh drying. RIM water control structures may include: 1) flapgated culverts installed through the impoundment dike, and 2) a permanent or dedicated pump. General guidelines for RIM management have been developed by SOMM.

Water Control Structures.

CULVERTS. Research has shown that, to approach natural conditions, culverts should be made of a non-corroding material (most commonly aluminum), should be a minimum of 30 in. diameter, and be equipped with a structure that will allow trapping of tidal water when closed and passage of water when open. Culverts should be spaced at 500 m intervals or less and should be placed where natural tidal creeks, basins or sloughs intersect the dike. Invert elevations should be set at -1.0 ft. NGVD (National Geodetic Vertical Datum).

PUMPS. A permanent or dedicated pump is necessary for optimal water level manipulations. Pumps can be electric or diesel, with automatic or manual operation.

RIM Variations:

RIM is flexible, allowing for the incorporation of new techniques or management findings that prove beneficial. Some variations to a standard RIM protocol are discussed below.

BLEED DOWN OR BOTTOM WATER RELEASE STRUCTURES. During the summer, when culverts are closed, water quality in some impoundments can deteriorate, particularly in deep perimeter ditches. In such situations, water control structures that allow a slow release of bottom waters have usefulness in improving water quality within the impoundment.

PERIODIC DRAWDOWNS DURING THE CLOSED SUMMER PERIOD. Impoundments can be drained for a short duration during the normally flooded summer period to allow marsh soils to dry and oxidize. This technique may be used to reduce hydrogen sulfide build-up in marsh soils.

CONSTANT BLEED. This technique requires pumping of estuarine water into the impoundment in excess of what is necessary for mosquito control. Excess water is allowed to either spill over riser structures or escape through bottom water release structures thus creating a flushing effect. Flushing may affect the whole impoundment, or may only be effective throughout the perimeter ditch.

DITCHING. In some instances, shallow ditches constructed by hand or with a rotary ditcher can extend the open RIM period allowing the marsh to provide more natural functions. By connecting salt-marsh mosquito breeding areas to deeper ponds or ditches, mosquito production can sometimes be abated by improving drainage and/or allowing larvivorous fish improved high marsh access. However, ditching has the possibility to promote marsh drainage and may increase habitat for sandfly production (*Culicoides* spp.).

SPECIFIC SPECIES MANAGEMENT. Variations of the standard RIM technique may be incorporated to manage for an individual or group of animal species. An example is a winter flood period with gradual water level drawdown to concentrate fish in shallow waters, thus providing improved feeding possibilities for wading birds.

Advantages:

1) Many natural marsh functions are re-established (e.g., access to the marsh for transient organisms).

2) Allows for seasonal source reduction mosquito control.

3) By flooding to only minimal levels during the summer months with a winter dry-down, indigenous marsh vegetation has a better opportunity to survive and/or re-establish.

4) The technique is economical.

Disadvantages:

1) Because the marsh is not flooded year-round, some larvicide applications may be necessary.

2) Flooding the marsh during the summer months is not a natural occurrence in this area and thus may cause problems with

water quality and problems to some indigenous flora and fauna (e.g., displacement of *Uca* populations from the marsh surface).

(II.A.4) SEASONAL DRAWDOWN

Seasonal drawdowns take advantage of the water management capabilities of impounded marshes to enhance habitat utilization by groups of species, to promote growth of desirable food plants, and to maximize management opportunities by following seasonal management needs.

The exact schedule of culvert opening and closing, and the time periods during which impoundments are in a drawdown stage can vary considerably depending upon local conditions. During open portions of the cycles, the opening can be complete or partial, and may be continuous or alternating. Some likely drawdown scenarios are described below.

(a) SUMMER DRAWDOWN

Summer drawdown management is a modified RIM technique that provides increased wading bird foraging habitat. The impoundment or cell of an impoundment is periodically drained during the summer months by opening the culverts and allowing water levels to fall over a period of 11 to 17 days to the level of the lagoon, which essentially drains the marsh. Later, a high tide can be trapped once the culverts are closed.

The summer months are particularly important for wading birds in coastal systems. During this time, water levels are naturally low, often nearly exposing seagrass beds, and coastal marshes are under low water levels and periodic natural drawdowns. Manipulated summer drawdowns may be equivalent to the historical conditions when the low water levels associated with the summer months may have provided an important foraging habitat for post-breeding and juvenile wading birds, classes that are often ignored in management plans due to their dispersed population structure.

Water Control Structures:

CULVERTS. Research has shown that culverts used for RIM management may be used to facilitate summer drawdowns.

PUMPS. A permanent or dedicated pump is desirable for optimal water level manipulation. Pumps can be electrical or diesel, with automatic or manual operation. However, studies have shown that in certain areas of the lagoon, the lunar tidal cycle is often sufficient to flood and drawdown impoundments.

Hydrological Regime:

Drawdown cycles begin with the flooding of the impoundment by entrapment of high tidal water associated with a new moon. The culverts are then closed and the impoundment remains flooded for approximately two weeks. Before the start of the cycle, impoundments can be pumped high for over one month. This high water period is referred to as the "pre-drawdown condition".

The exact schedule of culvert opening and closing, and the time periods during which the impoundment is in a drawdown stage can vary considerably depending upon local conditions. A typical scenario is described below.

The drawdown begins by partially opening the culverts at high tide during full moon, when estuarine water level is expected to be at the second highest point of the monthly lunar cycle. The timing is important to assure that the impoundment is drawn down gradually. After one week, the entire flapgate is opened, thus releasing the maximum amount of water from the impoundment. When the water in the impoundment reaches its lowest point, just after opening the entire flapgate, the impoundment is said to be in its maximum drawdown (max-drawdown) condition.

Drawdown impoundments usually remain open for two weeks (flapgate partially open for 1 week, entire flapgate open for 1 week) until the next new moon. The final stage involves catching the next high tide and closing the culverts. After this, the impoundment can be left flooded, or a new cycle can be started.

End of Summer Drawdown:

RIM impoundments that have been flooded during the entire summer can follow the same drawdown pattern when they are opened to the lagoon in the fall. If the impoundments are opened before the fall high tides, drawdowns can occur and thus be beneficial to wading birds. If the impoundments are opened after the fall high tides, the drawdown effect will not be as significant.

Impoundment blocks may be opened rotationally before the high tides impact the system. For example, two impoundments may begin bottom water release on July 15, two on July 29 and two on August 12, etc., thus increasing the foraging habitat available to wading birds and shore birds. This approach may be more advantageous than opening all of the impoundments in a particular county during the same week.

Faunal Management:

Experimental drawdown studies have shown that Great Egrets were more common during drawdowns while Snowy Egret numbers

peaked at drawdown, but the species was rarely observed when the impoundment was closed and water level was high. Although quantitative data are limited, Wood Stork responses to the drawdowns paralleled those of the Great and Snowy Egrets.

Adult and juvenile White Ibis were present in high numbers in the impoundments under all water level conditions. The relationship between drawdown conditions and number of Roseate Spoonbills is far less clear. The ground survey data available do not show any increase in the number of Roseate Spoonbills in response to drawdowns; however, aereal census data appear to contradict this, with significant increases in numbers detected at the time of maximum drawdown. Other observations suggest that large number of Roseate Spoonbills and Great Egrets feed in the lagoon at low tide rather than in the impoundments.

Advantages:

1) Wading birds respond very favorably, at the regional scale, to drawdown conditions. When drawdowns are available, the average number of birds per acre for drawdown impoundments has been found to be up to twenty times higher than the average number of birds per acre in RIM impoundments, and thirty times higher than in open impoundments.

Disadvantages:

1) There may be individual species that are negatively impacted by this hydrological regime.

(b) FALL/WINTER DRAWDOWN

This strategy is used mainly in the Merritt Island National Wildlife Refuge to promote growth of food plants for migratory birds. It involves summer flooding, with a fall/winter drawdown and a spring opening. It is often implemented in a cyclic manner, with one to several years of fall/winter drawdown alternating with one to several years when the impoundment is left open all year. The exact opening, closing and drawdown schedule varies depending upon lagoon water levels, rainfall, and physical conditions within the impoundment.

Advantages:

1) Results in good food production and habitat for migratory birds and waterfowl.

Disadvantages:

1) Access to the marsh is restricted during most of the year.

(c) WINTER FLOODING/SPRING DRAWDOWN

This technique was developed originally to improve feeding opportunities for wood storks during their nesting season. Under this protocol, the impoundment is flooded by pumping in January and holding the water up for a minimum of 60 days, followed by a gradual drawdown. The flooding period allows for the production of resident fish, which are then concentrated as the water levels recede, thus improving feeding conditions for wading birds. This technique is most appropriate in the vicinity of rookeries.

Advantages:

1) Provides food and suitable feeding conditions for birds during the nesting period, when forage requirements are greatest.

Disadvantages:

1) Marshes are flooded during a time of the year when they would normally be dry.

2) Increases cost of management.

3) If not timed correctly may interfere with natural bird feeding opportunities at start of winter.

(d) PRE-SUMMER DRAWDOWN

This techniques involves drawing down a flooded impoundment for a minimum of two weeks in late spring or early summer. During draw-down, moist soil conditions promote re-seeding of *Ruppia maritima*, an important waterfowl food plant. The impoundment is then gradually re-flooded to encourage growth of the plants. To encourage waterfowl use, the impoundment remains flooded until late spring.

Advantages:

1) Good food production and habitat for waterfowl.

Disadvantages:

1) Access to the marsh is restricted during most of the year.

(II.A.5) CYCLIC MANAGEMENT

Cyclic impoundment management involves the rotation of several different management techniques in different cells of an impoundment or in groups of impoundments. The rotation may be seasonal, or different techniques may be applied during succeeding years. Objectives may include wildlife enhancement (primarily waterfowl), runoff filtration, saltmarsh vegetation enhancement, and mosquito control.

The most common strategy involves a 3-year rotational cycle. Impoundments are prepared for one year before the rotation starts. The preparatory phase can include saltwater flooding of cells, burning of vegetation, and drawdown to eliminate weedy vegetation such as cattail. Those cells not in active cyclic impoundment management are usually maintained under RIM.

The first active year, a cell is flooded by June and flooding continues with closed culverts through December, at which time the culverts are open. The second year the cell is flooded with Indian River Lagoon water in November and then drawn down in February; therefore there is no flooding for mosquito control during the summer of that year. Some restriction to marsh-estuary water flow may be imposed during this period for salinity or overdraining control. The third year, after the culverts are opened in February, the cell follows standard RIM.

Other cells in the group begin the same cycle in sequence one year behind. The whole process can then be repeated every three years.

Advantages:

1) A great deal of variety can be introduced in a modest area.

2) Complementary strategies can be implemented in neighboring impoundment groups.

3) Management can be adjusted to optimize seasonal utilization of the area.

4) Some strategies that may be beneficial, but which need not be implemented continuously (e.g. drawdowns for sediment oxidation) can be incorporated into the regular management schedule without precluding use of other strategies at other times.

5) If proper salinities can be maintained the area will be attractive to waterfowl, and provide waterfowl food.

6) The impoundment is unsuitable for mosquito and sandfly production during 2 out of 3 years.

Disadvantages:

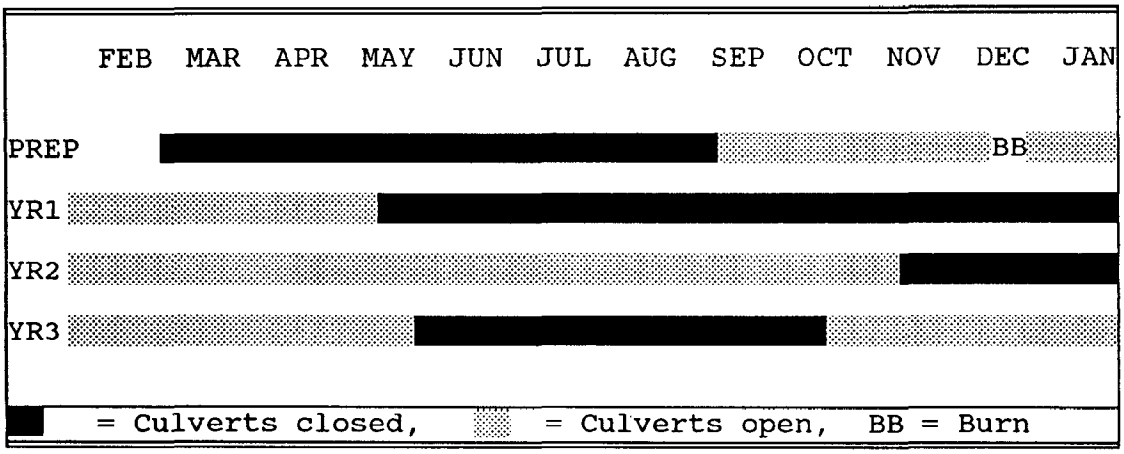
1) May be labor intensive and expensive to implement.

2) If not carefully designed, may result in fragmented management of areas too small to produce maximum benefits.

3) Access to the marsh by aquatic organisms is limited during 2 out of 3 years.

4) The impoundment is suitable for mosquito and sandfly production during 1 out of 3 years.

CYCLIC MANAGEMENT SCHEMATIC



(II.A.6) OPEN MARSH WATER MANAGEMENT (IMPOUNDED)

This mosquito control method reduces immature mosquito production by establishing more regular hydroperiods that are less conducive to mosquito oviposition, and by enhancing water exchange and circulation to allow recruitment and maintenance of larvivorous fish populations. It utilizes ponds, ditches and canals connected to tidal sources. In areas with a heavy concentration of mosquito-producing depressions, ponds are constructed so as to eliminate the depressions. The ponds serve as reservoirs for predatory fish during low water periods, and as water sources for nearby areas. Radial ditches may extend from the ponds to eliminate breeding in areas near the ponds. Ditches are also used to eliminate scattered breeding depressions and to interconnect the ponds, and deeper ditches are used to connect the system with a tidal source. Ditches are often silled at their connection to the lagoon to prevent over drainage of the high marsh during low tide periods. It is often used in impounded marshes to allow the marshes to remain open for longer periods of time, often throughout the whole year.

Detailed standards and protocols for OMWM have been produced for New Jersey (Bruder 1980; Proc. N.J. Mosq. Control Assoc. **67**:72-76), Maryland (Lesser 1982; Proc. N.J. Mosq. Control. Assoc. **70**:29-34), and Delaware (Meredith *et al.* 1985; Wetlands **5**:119-133), and various modifications of OMWM have been devised for dealing with slight tidal ranges and unpredictable tidal events (closed systems, ditch sills, etc.). In Florida, the method has been modified to suit the Indian River's low tidal amplitudes. The use of both open and closed systems, variations in the placement and height of silled connectors, and the use of graded, meandering ditches, are used to accomplish specific management needs.

Because of the small tidal amplitude in the Indian River Lagoon, and other limitations imposed by vegetation structure and equipment, opportunities for OMWM may be restricted along the lagoon. However, the technique may offer significant benefits in specific cases, or when used in combination with other techniques to achieve primary or secondary management goals.

Advantages:

1) Reduces pesticide use.

2) May increase suitable habitat for the endangered Atlantic salt marsh snake along the edges of ditches.

3) May allow breaching of dikes in some impoundments, or maintaining culverts open for longer periods of time in others.

4) Minimal system maintenance can be expected for up to ten years.

5) Provides a passive management system that requires little personnel for operation.

6) Increases edge habitat.

7) Variations in techniques provide flexibility for different situations and/or objectives.

Disadvantages:

1) Works best in areas with high tidal energy.

2) Limited applicability in areas dominated by mangroves because the necessary modifications would be difficult to construct.

3) Marsh hydrology changes, with lowering of water table a distinct possibility.

4) May require maintenance and, possibly, continued modification as conditions in the marsh change. Periodic inspections are needed to keep track of changing marsh conditions.

5) May foster the spread of mangroves into salterns and herbaceous halophyte areas and of invasion of salterns by herbaceous halophytes.

6) Depends partially upon weather and tidal events, which may cause control failures in part of the marsh. Larval inspections are still necessary.

(II.A.7) CONTINUOUS BLEED

This type of management is generally accomplished by pumping enough water into the managed system so that its water level is higher than the surrounding estuary. This allows for a constant flow of water out of the managed area (through bottom water release culverts or over flapgate risers) into the estuary. Many modifications of this technique can be done. For example, water levels could be kept at a level that would allow for high tides to augment the input from the pumps. This modification would allow tidal water to enter the marsh at selected tidegates giving the manager much flexibility in determining inflow and outflow points. Because tides tend to be variable, this technique can be combined with tidal trapping allowing the manager to use the pumps when tides are low and natural tides when tides are high. Like many other management schemes, this method can be combined with other techniques for increase management versatility.

Advantages:

1) Creates a flow through system, giving the manager a choice of options on the amount of water released and the location of release points.

2) Can easily vent water from top or bottom by using various tidegate configurations.

3) Tends to improve water quality by continually circulating water in the system.

4) May compensate for the absence of natural tidal flushing which is found in many natural systems.

5) Allows for great versatility in management.

Disadvantages:

1) Running pumps for long periods of time is expensive.

2) Pump failure may cause large fish mortalities because of sudden decrease in water quality.

3) May cause the managed system to depart too much from the type of system which would normally be found in a marsh/swamp environment (are we creating an aquarium?).

(II.A.8) OTHER

A variety of other techniques may be utilized, alone or in combination to attain specific management objectives. These techniques may represent a temporary change in management (e.g. leaving an impoundment open during a specified period of time to oxidize the sediments and then resuming normal management), or they may be permanent management strategies (e.g. stormwater retention). Some (e.g. exotic removal, prescribed burns) may be applied in conjunction with other strategies.

Many variations on the standard management options can be envisioned; some possibilities include: (1) prescribed burning, (2) stormwater processing, (3) overflooding, (4) scheduled exotic removal, (5) wastewater retention, and many others. Specific techniques will vary depending upon the objectives and the structure of the impoundment(s) in question.

(II.B.6) OPEN MARSH WATER MANAGEMENT (UNIMPOUNDED)

This mosquito control method reduces immature mosquito production by establishing more regular hydroperiods that are less conducive to mosquito oviposition, and by enhancing water exchange and circulation to allow recruitment and maintenance of larvivorous fish populations. It utilizes ponds, ditches and canals connected to tidal sources. In areas with a heavy concentration of mosquito-producing depressions, ponds are constructed so as to eliminate the depressions. The ponds serve as reservoirs for predatory fish during low water periods, and as water sources for nearby areas. Radial ditches may extend from the ponds to eliminate breeding in areas near the ponds. Ditches are also used to eliminate scattered breeding depressions and to interconnect the ponds, and deeper ditches are used to connect the system with a tidal source. Ditches are often silled at their connection to the lagoon to prevent over drainage of the high marsh during low tide periods.

Detailed standards and protocols for OMWM have been produced for New Jersey (Bruder 1980; Proc. N.J. Mosq. Control. Assoc. **67**:72-76), Maryland (Lesser 1982; Proc. N.J. Mosq. Control. Assoc. **70**:29-34), and Delaware (Meredith *et al.* 1985; Wetlands **5**:119-133), and various modifications of OMWM have been devised for dealing with slight tidal ranges and unpredictable tidal events (closed systems, ditch sills, etc.). In Florida, the method has been modified to suit the Indian River's low tidal amplitudes. The use of both open and closed systems, variations in the placement and height of silled connectors, and the use of graded, meandering ditches, are used to accomplish specific management needs.

Because of the small tidal amplitude in the Indian River Lagoon, and other limitations imposed by vegetation structure and equipment, opportunities for OMWM may be restricted along the lagoon. However, the technique may offer significant benefits in specific cases, or when used in combination with other techniques to achieve primary or secondary management goals.

Advantages:

1) Reduces pesticide use.

2) May increase suitable habitat for the Atlantic salt marsh snake along the edges of ditches.

3) In open systems, a connection can be maintained year round

between the marsh and the estuary. Usually results in improved water quality and more stable water levels.

4) Minimal system maintenance can be expected for up to ten years.

5) Provides a passive management system that requires little personnel for operation.

6) Increases edge habitat.

7) Variations in techniques provide flexibility for different situations and/or objectives.

Disadvantages:

1) Works best in areas with high tidal energy.

2) Limited applicability in areas dominated by mangroves because the necessary modifications would be difficult to construct.

3) Marsh hydrology changes, with lowering of water table a distinct possibility.

4) May require maintenance and, possibly, continued modification as conditions in the marsh change. Periodic inspections are needed to keep track of changing marsh conditions.

5) May foster the spread of mangroves into salterns and herbaceous halophyte areas and invasion of salterns by herbaceous halophytes.

6) Depends partially upon weather and tidal events, which may cause control failures in part of the marsh. Larval inspections are still necessary.

(II.B.2) DITCHED

This category includes marshes that were ditched in the past (particularly during the 1940s and 1950s) in attempts to control mosquitoes; It does not include ditches constructed as part of OMWM systems or shallow ditches that may be used to complement RIM. The usual strategy was to construct an evenly-spaced grid system of deep ditches that would drain the marsh and often lowered water tables. This approach was not successful because considerable breeding still occurred between the ditches. Furthermore, spoil deposition in the marsh interfered with sheet flow and provided sites for invasion by exotic species and upland plants.

Many of these ditches have fully or partially closed with time, particularly at the marsh-estuary edge. Although new ditch systems of this type are not likely to be constructed, maintenance of old ditches may be advisable in some cases as some of the ditches may promote water circulation and may be used as part of other management strategies. Partially closed ditches are often heavy mosquito producers, and may require maintenance to prevent mosquito production and water stagnation. Finally, spoil piles or berms created by this technique often block water movement and may have to be removed.

Advantages:

1) In some marshes where the deep ditches have remained functional, mosquito breeding has been reduced, thus reducing the need to use pesticides for mosquito control.

Disadvantages:

1) Frequently not effective for long term mosquito control.

2) Spoil piles created by the deep ditching interfere with sheet flow, block circulation, and promote invasion by exotics and upland plants.

3) Often lowers marsh water table.

4) Has made traversing some marshes virtually impossible, thereby hindering inspections for larval mosquitoes.

5) Ditch banks can be suitable habitats for sandflies.

(II.B.3) OTHER

As with impounded marshes, a variety of other techniques may be utilized, alone or in combination to attain specific management objectives. These techniques may represent a temporary change in management or they may be permanent management strategies. Some (e.g. exotic removal, prescribed burns) may be applied in conjunction with other strategies.

Many variations on the standard management options can be envisioned. Specific techniques will vary depending upon the objectives and the structure of the marshes in question.

F. STRATEGIES - OBJECTIVES

Specific management goals can be attained using different protocols. The "best" technique for attaining a particular goal will depend heavily on the structure of the impoundment(s) in question, on physical and geographic factors, and on management strategies in the surrounding areas. Below we list some likely combinations of management goals and strategies. The strategy most commonly used for a given objective is marked with ●.

TECHNIQUES

1. Closed
2. Open (modified or unmodified)
3. RIM
4. RIM & ditching
5. Continuous flooding
6. Seasonal drawdown
7. Cyclic
8. OMWM (impounded or unimpounded)
9. Continuous bleed
10. Ditched

GOAL	1	2	3	4	5	6	7	8	9	10
Mosquito Ctrl.	■		●	■	■		■	■	■	
Waterfowl	■				●	●	■			
Linkage		●		■				■		
Fish		■	■					●		
Wading Birds						●		■		
Mammals	-	-	V	A	R	I	E	S	-	-
Endangered Spp.	-	-	V	A	R	I	E	S	-	-
High Marsh Spp.		●						■		
Exotic Ctrl.		■	■		■					
Water Quality		●	■	■			■	■	●	
Inveterbrates		■	■	■		■	■	●		
Recreation	■	■	■	■	■	■	■	■	■	
Education	■	■	■	■	■	■	■	■	■	
Research	■	■	■	■	■	■	■	■	■	
Other	-	-	V	A	R	I	E	S	-	-

G. MANAGEMENT STRATEGIES FOR THE JENSEN BEACH, OSLO, SEBASTIAN INLET, AND MOSQUITO LAGOON MANAGEMENT AREAS

Below are the specific management strategies for the three Lagoon Management Areas selected for completion under the current project, plus plans for the Sebastian Inlet Management Area, which were completed prior to the start of this project. Plans for each area are followed by a map of the area with the suggested management for each impoundment. Impoundments denoted by a circle are suggested for public acquisition.

JENSEN BEACH MANAGEMENT AREA MANAGEMENT STRATEGIES

General Comments:

Management of some of the impoundments in this area is influenced by activities at the St. Lucie Nuclear Power Plant. Some impoundments receive runoff from the plant, which limits the potential pollution to the lagoon, whereas education and vegetation recovery projects are in progress in others.

Many of the impoundments in the JBMA maintain significant marsh-lagoon connections when compared to other areas, and suggested management modifications emphasize enhancement of flushing and internal circulation. Seasonal drawdowns for wading birds is recommended for several impoundments presently managed under RIM. Priorities for public acquisition are assigned to the remaining portion of impoundment 10A still under private ownership, and to impoundment SLC-12/MC-A1

Impoundment 6. - This is a relatively low impoundment, with many open water areas in its interior. It is not well suited for drawdowns for wading bird usage as it is difficult to maintain sufficiently low water levels to make the habitat attractive. However, the many open water areas provide significant habitat for fishes and other aquatic organisms, and increasing access to these areas should be a priority. To this end, five to ten external culverts need to be added to the north side of the impoundment to increase access opportunities and to promote flushing and circulation as part of the current RIM management strategy.

Impoundments 7 and 8A. - These impoundments offer a unique educational opportunity because of the interpretative trails and catwalks constructed by Florida Power and Light. RIM management can be continued without detracting from the educational potential of the area. Additional facilities would be extremely beneficial to increase the educational impact of the area. In particular, additional plant identification tags are needed. Also, larger signage, depicting the structure and function of tidal marshes and mangrove forests, and explaining the purpose, function, and management of impoundments are extremely desirable. These signs could be installed at one location in an open shelter/rest structure, or they can be spread throughout the trails. Additional bird observation catwalks on the east and west sides would also be beneficial. The area is secure because of restricted access and supervision by FP&L personnel, so investment in these educational facilities is relatively safe from vandalism.

Impoundments 8B and 8C. - These two impoundments are prolific mosquito producers and should be kept under RIM. However independent pumping capabilities for the two cells are urgently needed as excessively high water levels are being maintained in impoundment 8C to allow flooding of 8B. This is necessary to allow water flow over a spoil ridge that separates the two marshes. Vegetation mortality is evident at 8C, partly due to the high flooding elevations. Installing a pump at 8B would allow proper flooding elevations at the two sites and vegetation recovery at 8C. Alternatively, the spoil ridge could be removed, but this area presently supports luxuriant mangrove growth which would be eliminated if the spoil is scraped away. Internal culverts, and limited rotary ditches may also enhance flushing and circulation throughout the cells.

Impoundment 8D. - This marsh can be left open during most years. If mosquito production becomes a problem, it can be flooded for two to three weeks via tidal trapping and then reopened.

Impoundment 8E. - Present management of this area consists of short term flooding (3 weeks per month) followed by a one-week open period. This strategy is being used to promote the recovery of mangrove vegetation. The three-week flooding period is necessary to provide salt water to the substrate, which otherwise would remain too dry for optimal mangrove growth, to control mosquito production, and also to avoid colonization by undesirable vegetation such as cattails and higher ground exotics. Provisions for off-season flooding for irrigation, exotic control, wading bird utilization, and protection against freezing should be maintained for this area.

Impoundments 8F, 8G. - These impoundments are used as stormwater retention areas for the St. Lucie Nuclear Power Plant, a strategy that minimizes excessive runoff into the lagoon. They are small, isolated areas which can not be interconnected to cycle different management strategies in the group. It is desirable to maintain high profile vegetation in these areas to minimize bird utilization because of possible contamination with pollutants carried by the runoff.

Impoundments 8H, 8I. - Can be left open unless mosquito production becomes a problem, in which case short term flooding (2-3 weeks) via tidal trapping can be used for mosquito control.

Impoundment 9. - This marsh contains a number of small hammocks that should be protected. Exotic vegetation control is important. The area can be best managed under a modified RIM strategy, which includes several drawdowns during the summer for wading bird use.

Impoundment 9 Annex. - Although management of this impoundment can be similar to the above, it needs to be managed as a separate unit

because marsh elevations are significantly lower and therefore, water levels must be adjusted independently. Some mangrove and herbaceous halophyte plantings have been proposed for this area as part of a mitigation project.

Impoundment 10A. - This impoundment is unmanaged except for a 40 acre portion in the northeast section, which is managed by tidal trapping through a single culvert. This 40-acre segment is separated from the rest of the marsh by uplands, and by a low east-west road constructed many years ago. Because of this isolation, this segment has been responsible for a large part of the mosquito production from this marsh. Tidal trapping is only partially effective in controlling the mosquito problem.

The rest of the marsh is relatively flat, and lies at an elevation of slightly less than 1 foot NGVD. As a result of the low elevation, the marsh is regularly flooded by tides, and mosquito production is not a major problem. However, there is an extensive network of old ditches that can cause a significant sandfly problem. The south portion of the dike is breached and penetrated by eight 30" culverts. The north portion has eight 36" culverts, but these are non-functional because of sand blockage. Unique tropical hammocks border the marsh on the east, and penetrate into the marsh at several locations.

Because of the diversity of habitats in this marsh, it is a good candidate for installation of boardwalks and nature trails. A pump, possibly solar-powered, needs to be installed in the 40-acre northeast section, to allow effective mosquito control via RIM. Flushing and circulation need to be improved in the rest of the marsh to ameliorate the sandfly problem. To this end, the plugged culverts need to be replaced, and the effectiveness of additional breaches needs to be explored.

Impoundment 10B. - The dike in this impoundment is in bad condition, with two natural breaches and one non-functioning culvert. It should be left open but internal circulation needs to be improved by adding additional breaches and/or culverts, particularly at the north and south ends of the marsh.

Impoundment 10C. - This is a small impoundment with a single 24-inch polyethylene pipe connecting the marsh and the lagoon. It can be left open all year. Some cleanup and access control are desirable as the area has sometimes been used as a trash dump.

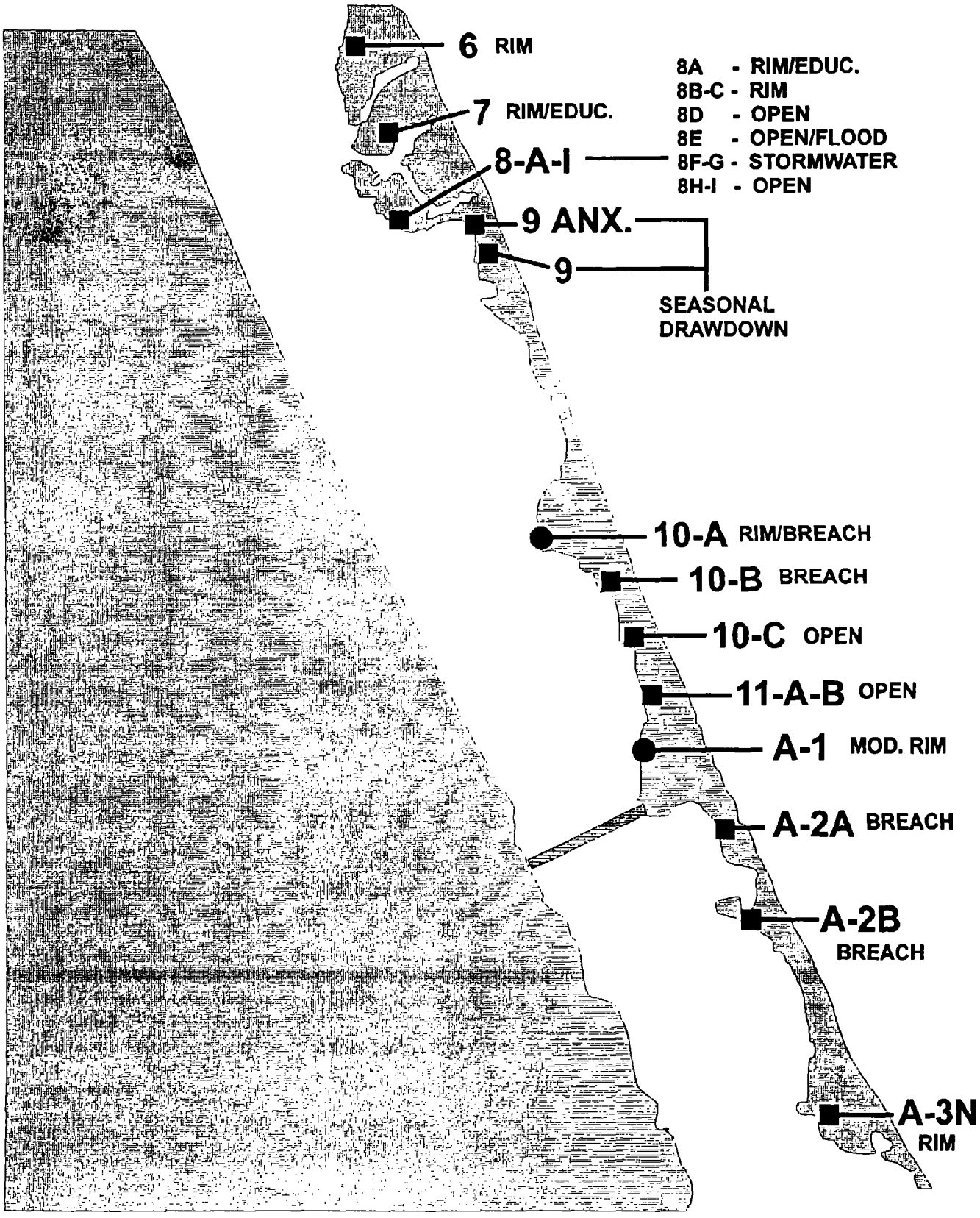
Impoundments 11A and 11B. - A low berm separates impoundment 11A from 11B. 11B is an open water area separated from the lagoon by a dike with a breach on the south end which should remain open. One culvert on the south side of the internal berm connects the two impoundments. An additional culvert is needed on the north end of the internal berm to foster circulation and flushing. Additional breaches on the 11B dike may also be desirable.

Impoundment 12/A1. - Presently, this impoundment is open all year through 8 culverts. However, the area is a prolific mosquito producer and requires frequent larviciding. Pesticide use can be eliminated by establishing a RIM protocol. Elevation in this marsh is relatively low, and effective mosquito control may be effected by a shorter closed/flooded period than normal (portions of June, July and August). Property owner concurrence, however, is a problem and purchase of this tract is highly desirable. An electric pump (and pump station) would be necessary for implementation of RIM. Exotic vegetation control is needed in some areas of this marsh.

Impoundment A2A and A2B. - The dikes in these two impoundments have been breached. Marsh substrates are relatively low and, therefore, the whole area receives frequent tidal flushing and need no further modification.

Impoundment A3N. - This previously isolated impoundment has recently been placed under a RIM protocol as part of an Indian River Lagoon National Estuary Program Action Plan Demonstration Project. A great deal of research has been undertaken in this marsh and in the adjoining lagoon, and regular monitoring of basic water quality variables is still under way. The Florida Oceanographic Society has constructed a series of catwalks throughout the marsh as part of their educational program, and additional catwalks and signage are being planned. Obtaining funding for completion of these projects is a high priority. RIM management should be continued. Provisions for education and research are also appropriate for this marsh.

JENSEN BEACH MANAGEMENT AREA



OSLO MANAGEMENT AREA
MANAGEMENT STRATEGIES

General Comments:

This area is important for wading birds and waterfowl because further south mangroves begin to monopolize and eliminate the open space requirements of many species. Exotic vegetation control is important throughout the area but only the most urgent cases are mentioned in the impoundment descriptions. Priority for public acquisition is assigned to impoundments 11, 12 and 14-16 (Indian River County).

Impoundments 19 to 21 in Indian River County have potential to function as stormwater processing areas because of their location adjoining the city of Vero Beach. We have suggested such function for impoundment 19 because it presently receives outfall from a treatment plant that will cease operating within the next few years and therefore the marsh character is mostly that of freshwater wetland. Furthermore, a relief canal runs next to the marsh thus simplifying the logistics. Use of the other two impoundments for this purpose should be addressed in the future.

Impoundments 17 and 18 have unique educational potential. The University of Florida's Florida Medical Entomology Laboratory adjoining these impoundments runs an active educational program of which these impoundments are an integral part, the first as an example of a herbaceous halophyte marsh and the second of a mangrove dominated wetland. In the vicinity there are outstanding examples of hardwood hammocks, Florida scrub, and a pristine mangrove-herbaceous halophyte marsh, which together with the impoundment provide a unique cross section of important Florida habitats.

Impoundments 20 & 21. - These two impoundments are interconnected and are presently managed by flooding during the summer for mosquito control. There are no exchange culverts and the impoundments maintain standing water during most of the year. They are close to populated areas and are heavy producers of mosquitoes. A RIM protocol is suggested for both of them. An appropriate number of culverts connecting the impoundments with the lagoon need to be installed. Because of their location and the surrounding drainage patterns, these impoundments have a potential for use as stormwater retention areas.

Impoundment 19. - This impoundment has been receiving discharge from the Vista Royale treatment plant since 1976. It is anticipated that this plant will cease operation shortly. Because of the past history, the character of the impoundment is mostly that of a freshwater marsh. A drainage canal, carrying runoff from Vista Royal and U.S.1 runs along the south edge of the impoundment and is the only potential source for pumping into the impoundment when the treatment plant shuts down. Given that the area will probably remain fresh after the plant is closed, the impoundment will best be managed by using it as a runoff retention area. This can be accomplished by installing appropriate structures to divert the flow from the relief canal into the impoundment. Appropriate safety measures will need to be taken to handle water flow during storm events, and culverts will need to be installed in the impoundment along the lagoon to accommodate the water flow.

Impoundment 18. - Management plans have been developed for this impoundment that incorporate RIM, modified for maintenance of freshwater in one of the cells. There is an important rookery offshore of the impoundment, and educational facilities (catwalks, observation towers, interpretative trails) are also being planned. The Florida Medical Entomology Laboratory (University of Florida - IFAS) adjoins the impoundment and also maintains public educational facilities. Every effort should be made to complete the educational facilities planned for this impoundment.

Impoundment 17. - This is a breached impoundment with an outstanding mix of herbaceous halophytes and mangroves, and a permanent pond. The impoundment-lagoon connection needs to be improved through the addition of breaches or culverts, and by lowering portions of the dike to approximately 0.5′ NGVD to resemble the natural berm existing in the area. Some rotary ditching may be necessary in the future to control mosquitoes, particularly along the upland edge.

Impoundments 14, 15, & 16. - This is a system of three interconnected impoundments. Vegetation is a mix of mangroves, herbaceous halophytes, and open areas. This block of impoundments can be managed on an alternating summer drawdown regime to obtain a diversity of benefits not attainable with a single management strategy, while maintaining mosquito control capabilities. We visualize a schedule of one- to two-week drawdown in each of the impoundments with the whole process repeated after the last impoundment is drawn down. Existing culverts connecting the cells need to be replaced with larger ones with risers, and the number of interconnecting culverts need to be increased (at least 2-3 between each impoundment). Exterior exchange culverts need to be installed, and two additional electric pumps will have to be dedicated to the system. Because of the potential benefits derived from proper management of this block of impoundments, purchase of the three is of high priority.

Impoundment 13. - This impoundment consists of two cells divided by a road. It is presently flooded during the summer, but there are no exchange culverts with the lagoon. Culverts are needed along the lagoon so that a RIM protocol can be established. Also, better connections between the two cells are needed to increase circulation.

Impoundments 10A & 10B. - Presently, 10A is flooded year round. The open canopy nature of this impoundment, and its proximity to the rookery near 18A make this a good candidate for summer drawdowns. However, drawdown levels must be carefully controlled to avoid objectionable odor problems for the nearby residents of The Moorings. Impoundment 10B is breached and should remain so. Better connections with the lagoon (more breaches) will probably aid in water exchange and circulation.

Impoundment 11. - This is a large impoundment, with heavy mosquito production and located in close proximity to residential areas. It is presently flooded during the summer, but can not be reconnected at other times because of lack of exchange culverts. A battery of culverts are sorely needed along the western edge so that a RIM protocol can be established. However, multiple ownership, and lack of cooperation from several of the owners may preclude establishment of a proper RIM protocol. Purchase of this impoundment is also of high priority.

Impoundment 12. - This impoundment is presently being larvicided to control mosquito production in numerous depressions and potholes. Vegetation is mainly herbaceous halophytes. There are many bare areas and several permanent and semi-permanent shallow ponds. Because of its structure, the impoundment is an important shore bird habitat, and steps must be taken to assure that the impoundment remains open. To that end, limited rotary ditching to eliminate breeding in potholes, and some maintenance of the shallow ponds are advisable. The impoundment also needs culverts on the west extension to promote water circulation. A great deal of our knowledge of impoundment biology was acquired during many years of research at this site. Because of this, its importance as a bird habitat, and its proximity to Round Island State Park, efforts should be made to purchase this impoundment.

Impoundment 24. - This impoundment is similar to IRC #12 except that coverage by herbaceous halophytes and mangroves is much more complete. The area contains a large permanent pond and is traversed by a tidal channel that conducts water through the center of the marsh. The area contains several potholes that breed mosquitoes. Connection of these potholes to tidal water by rotary ditching or creating large permanent ponds at sites where potholes are most abundant is desirable. Otherwise, the same management strategy as in IRC #12 should be applied. If this impoundment and IRC #12 are purchased, a large contiguous tract could be created between Round Island Park and the state property to the south.

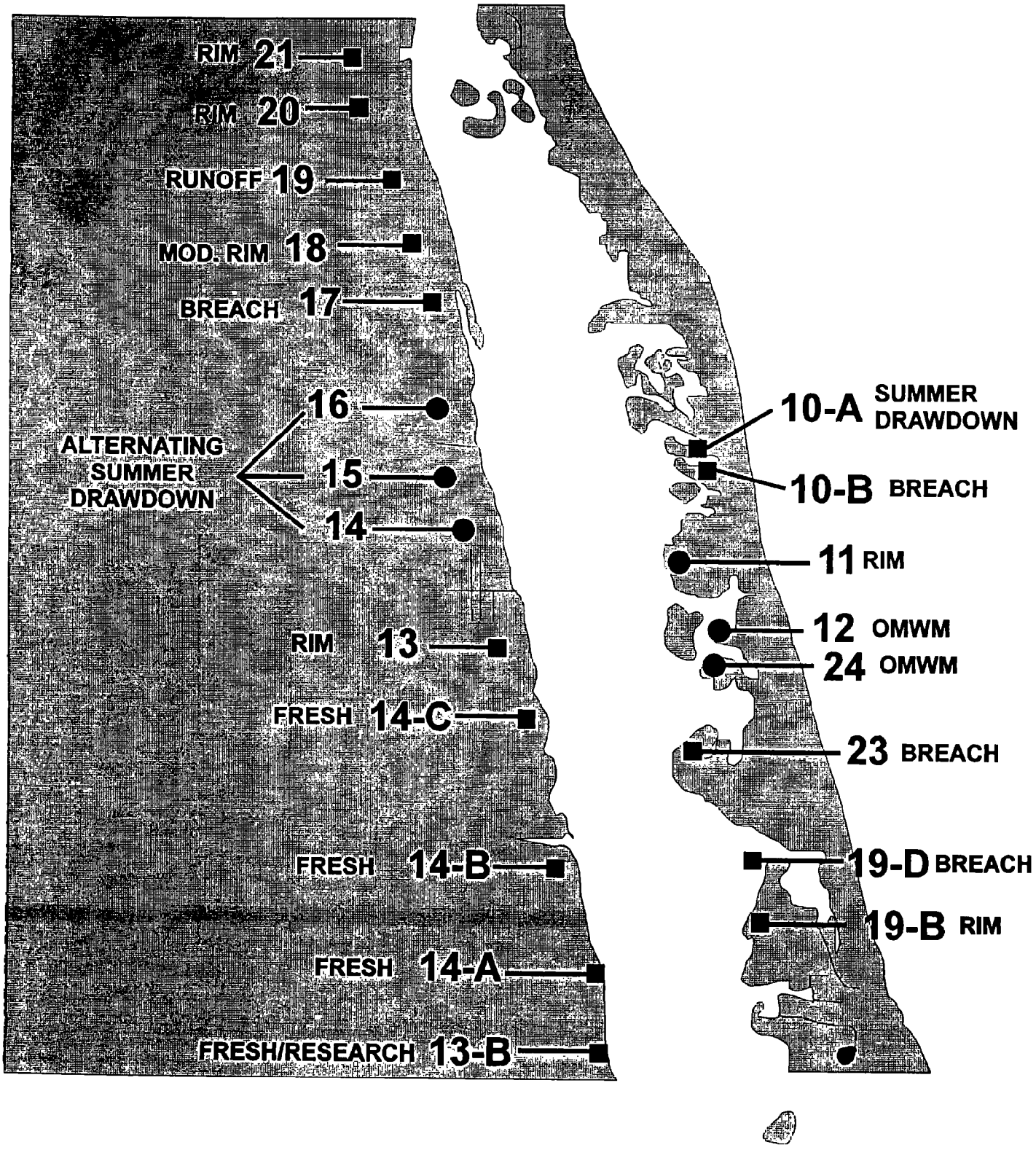
Impoundment 23. - The dike in this impoundment is breached, and should remain so. Water exchange and circulation should be enhanced by adding more breaches to the dike. Scraping down the dike to resemble the natural berm would be desirable as long as the spoil is not used to fill the perimeter ditch, which is effective in providing circulation and water exchange with the lagoon. Many old ditches are present throughout the marsh and many of these are partially filled in, thus providing pockets for water accumulation and stagnation. These old ditches should either be filled in or opened. There is a hammock along the upland edge of this impoundment with unique native vegetation that should be protected. Exotic plant control is a high priority in this marsh.

Impoundment 19D. - This island impoundment is breached. The dike should be removed as long as a suitable location for depositing the spoil can be secured. If the dike is not removed, the existing breach needs to be cleared, as it is presently filling in, and additional breaches should be created.

Impoundment 19B. - 19B is large impoundment with heavy mosquito production near populated areas. It should remain under RIM.

Impoundments 14C, 14B, 14A, and 13B. - These are basically fresh water systems with obvious connection to the upland Savannahs and are presently unmanaged. They support a wide variety of freshwater plant and animal species, and provide good feeding areas for ducks. Parts of the upland area adjacent to impoundment 14C contain a well developed maritime hammock which should be protected. We see no advantage in modifying these systems and their extensive freshwater flora and fauna. Some measure of cattail control, however, is urgently needed. Impoundment 13B should be reserved for research on management of these freshwater systems and on exotic control. Any desirable technique developed there would be directly applicable to the remaining impoundments in the group and to similar freshwater systems along the lagoon.

OSLO MANAGEMENT AREA



SEBASTIAN INLET MANAGEMENT AREA MANAGEMENT STRATEGIES

General Comments:

The development of plans for the Sebastian Inlet Management Area (SIMA) and their adoption by the Subcommittee on Managed Marshes in 1991 was the first effort at regional management plan development. This effort was initiated by Joseph Carroll, then with the U.S. Fish and Wildlife Service, acting as Chairman of the Subcommittee on Managed Marshes'(SOMM) - Working Group on Impoundment Management Planning. This concerted planning effort resulted in funding for plan implementation through cooperation between the St. Johns River Water Management District's SWIM Project and the Brevard and Indian River Mosquito Control Districts.

SIMA extends for approximately 16 miles from CR 510 in Indian River County northward to Hog Point in Brevard County and west to the Intracoastal Waterway. It includes all the salt marshes, mangrove swamps and mosquito control impoundments on the barrier island side of the Indian River lagoon as well as salt marsh islands (most of which have been ditched). SIMA's most notable feature is the Sebastian Inlet which is centrally located within this area. The location of the Inlet within SIMA is important, serving as an access point for an abundant supply of organisms entering the Indian River lagoon from the Atlantic Ocean. The St. Sebastian River is a major source of fresh water located due west of the Sebastian Inlet on the mainland side of the lagoon. Two important rookeries, Pelican Island and Grant Farm Island, influence wading bird utilization of marshes within SIMA. Pelican Island is the central focus of the Pelican Island National Wildlife Refuge (PINWR).

Other publicly owned areas within SIMA are the Sebastian Inlet State Park (located in both Brevard and Indian River Counties) and Long Point County Park (Brevard County). There are 15 impoundments within SIMA totalling 1,206 acres. Many of the impoundments are under RIM (or targeted for RIM). Indian River Impoundments #2 & #3 are under a cyclic winter pump-up and spring draw-down schedule for wading bird enhancement. These impoundments were chosen for this use because of their close proximity to Pelican Island and because of the documented benefits this management technique can provide. Approximately 340 acres of unimpounded island marshes and mangrove swamps occur in SIMA, most of which have been ditched in years past but still require frequent larviciding to control salt-marsh mosquito populations originating there.

Hog Point. - Plans are underway to implement RIM in this 106 acre impoundment but property owner approvals are pending. Currently this impoundment is closed, not pumped and has migrated largely toward a freshwater system.

North Grove. - Plans to implement RIM in this 57 acre impoundment are also under development. Currently the impoundment is seasonally flooded with no lagoon connection.

North Siphon. - This small 8 acre impoundment currently is open to the lagoon with 1 culvert. Adding another culvert is desirable to improve circulation and marsh-lagoon exchange.

John Smith. - This 157 acre impoundment is currently under a RIM plan with a total of 7 exchange culverts. One more culvert is desirable. Public efforts to purchase part of this impoundment are under consideration.

South Siphon. - This 16 acre impoundment is closed and not managed. Efforts to install 2 culverts are encouraged, but no capability to flood this impoundment exists, so an open connection should be maintained year-round.

Sunnyland. - The Aquarina Development owns this 60 acre impoundment Currently this marsh is seasonally flooded with a portable diesel pump but there is no connection with the lagoon. Plans for implementation of RIM are pending. When implemented, the plan will include 4 culverts and a permanent electric pump station.

Latham Hotel. - This 27 acre impoundment, which is also part of the Aquarina property, is closed and not pumped. A long-term plan to open it with 4 culverts is being considered and should be implemented.

Nancy Creek. - RIM is now employed at this 17 acre impoundment where 3 culverts have been installed. Pumping is accomplished with a portable diesel pump.

Long Point. - This 150 acre impoundment is located within Brevard County's Long Point Park and is managed via RIM. It is flooded with a stationary electric pump and 8 culverts allow it to be seasonally opened to the Indian River Lagoon.

Campbell's Cove. - This 68 acre impoundment, which is located within the Sebastian Inlet State Park, is RIM managed with a permanent electric pump and 4 culverts to allow seasonal marsh-estuary connection.

IRC #1 (Inlet). - Located within the Sebastian Inlet State Park, this 153 acre impoundment is RIM managed. After RIM was designated as the desired management technique for this marsh in the initial SIMA draft, SWIM funding allowed for the purchase of culverts and

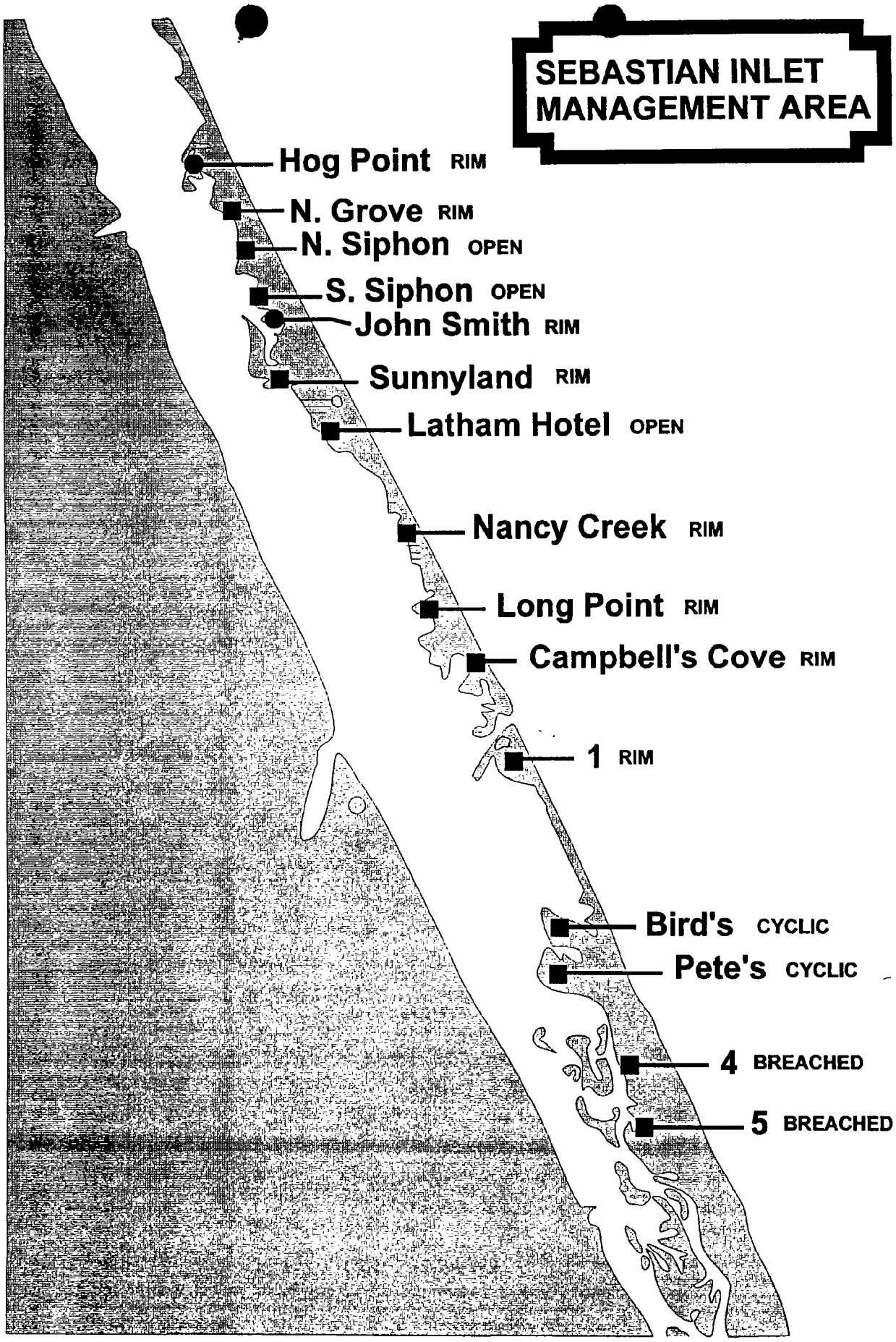
a permanent electric pump station which were installed at this impoundment by the Indian River Mosquito Control District (IRMCD). Currently there are 5 exchange culverts and 2 bleed-down culverts.

IRC #2 (Bird's). - Bird's Impoundment, which totals 156 acres, is managed on a cyclic winter flooding/spring drawdown scenario to allow in alternate years, the enhancement of feeding opportunities for wading birds. The winter flooding/spring drawdown function is alternated yearly with IRC #3 (Pete's). In years when the impoundment is not managed for wading birds, a RIM technique is used. The SWIM program, with IRMCD participation, has installed 5 exchange culverts and 2 bleed-down culverts on the portion of this impoundment that is in public ownership (the western half). Additional culverts are desirable on the eastern half of this impoundment when property ownership conditions allow. Also, a portable diesel pump was purchased to be shared between this impoundment and IRC #3.

IRC #3 (Pete's). - Pete's Impoundment, which totals 150 acres, is like IRC #2 in that it is managed on a cyclic winter flooding/spring drawdown scenario to allow in alternate years, the enhancement of feeding opportunities for wading birds. The winter flooding/spring drawdown function is alternated yearly with IRC #2 (Bird's). The SWIM program, with IRMCD participation, has installed 5 exchange culverts (with 2 bleed-down culverts scheduled for installation this winter). Also (as mentioned in the description of IRC #2 above), a portable diesel pump was purchased and is shared between this impoundment and IRC #2.

IRC #4 (North Deerfield). - This 51 acre impoundment, which is privately owned, is breached in two locations and is a prolific producer of salt-marsh mosquitoes. Even though it is open to the estuary through breaches, improved circulation could be accomplished with culverts or additional breaches.

IRC #5 (South Deerfield). - This 30 acre impoundment, like IRC #4 is privately owned, and breached in one location. It is also a prolific producer of salt-marsh mosquitoes. It is open to the estuary through one breach, but as with IRC #4, circulation could be improved with culverts or additional breaches.


SEBASTIAN INLET
MANAGEMENT AREA
Hog Point RIM
N. Grove RIM
N. Siphon OPEN
S. Siphon OPEN
John Smith RIM
Sunnyland RIM
Latham Hotel OPEN
Nancy Creek RIM
Long Point RIM
Campbell's Cove RIM
1 RIM
Bird's CYCLIC
Pete's CYCLIC
4 BREACHED
5 BREACHED

MOSQUITO LAGOON MANAGEMENT AREA MANAGEMENT STRATEGIES

General Comments:

Many of the impoundments in this area are located within the Merritt Island National Wildlife Refuge. There are several unimpounded marshes in the area, particularly in Volusia County, and several impounded marshes remain open all year with mosquito control accomplished via OMWM.

The MINWR presently operates under the mandate of providing habitat and food for migratory birds and waterfowl. As such, management of many of these impoundments revolve around production of food plants and provision of suitable resting and foraging habitat for these birds; however, more emphasis on "ecosystem management" is probably forthcoming. A fall/winter drawdown schedule, alternating with years when impoundments are left open is the most common technique utilized presently for migratory bird management. However, management versatility is critical for achieving the stated goals. Refuge managers need the flexibility to alter the management of individual or groups of impoundments to cope with unpredictable weather conditions, and to maintain suitable habitat quality in these marshes.

Two factors presently limit the efficient management of many of the refuge impoundments: 1) Insufficient pumping capabilities, and 2) shortage of personnel to operate pumps and culvert gates. In the MLMA, the first problem could be resolved by installing a 36-inch pump in impoundment T-27A, which could be used to control water levels in close to 4,000 acres of impounded marshes. With pumping capabilities and additional field technicians, many of these impoundments could be opened sooner and/or closed later, thus maximizing the time where effective marsh-lagoon interchange is maintained. Obtaining funding for purchase and installation of said pump is important for this area, and for the lagoon as a whole.

Management of many of the MINWR impoundments under a fall/winter drawdown schedule limits the connections between marshes in this area and the lagoon, both in a temporal and a spatial sense. However, the management strategy for many of these impoundments includes periodic year-round opening, which should be staggered among sites so that some impoundments are open at any given time. Nevertheless, every effort should be made to maintain the marsh-lagoon connection in the remaining marshes in the area. Fortunately, many of the Volusia County impoundments can be managed

under an OMWM strategy. These, together with the unimpounded marshes in the area, offer the best opportunities for balanced management.

Impoundment C-8. - This impoundment is breached with rotary ditches and should be left as is.

Impoundment D-2. - This impoundment receives a great deal of runoff from the uplands and is a good candidate for use as a stormwater retention area. The four existing culverts could be closed during high runoff periods, and/or riser boards installed to control discharge into the lagoon.

Impoundment D-12N. - This is an isolated insular impoundment whose main water input is from rainfall and groundwater. As a result there is a proliferation of cattails and duckweed. This marsh could be best managed as an OMWM system with breached dikes. Prescribed burning may be necessary to eliminate some of the unwanted vegetation.

Impoundment D-12S. - This marsh can be kept open all year if more ditches are constructed to eliminate mosquito breeding.

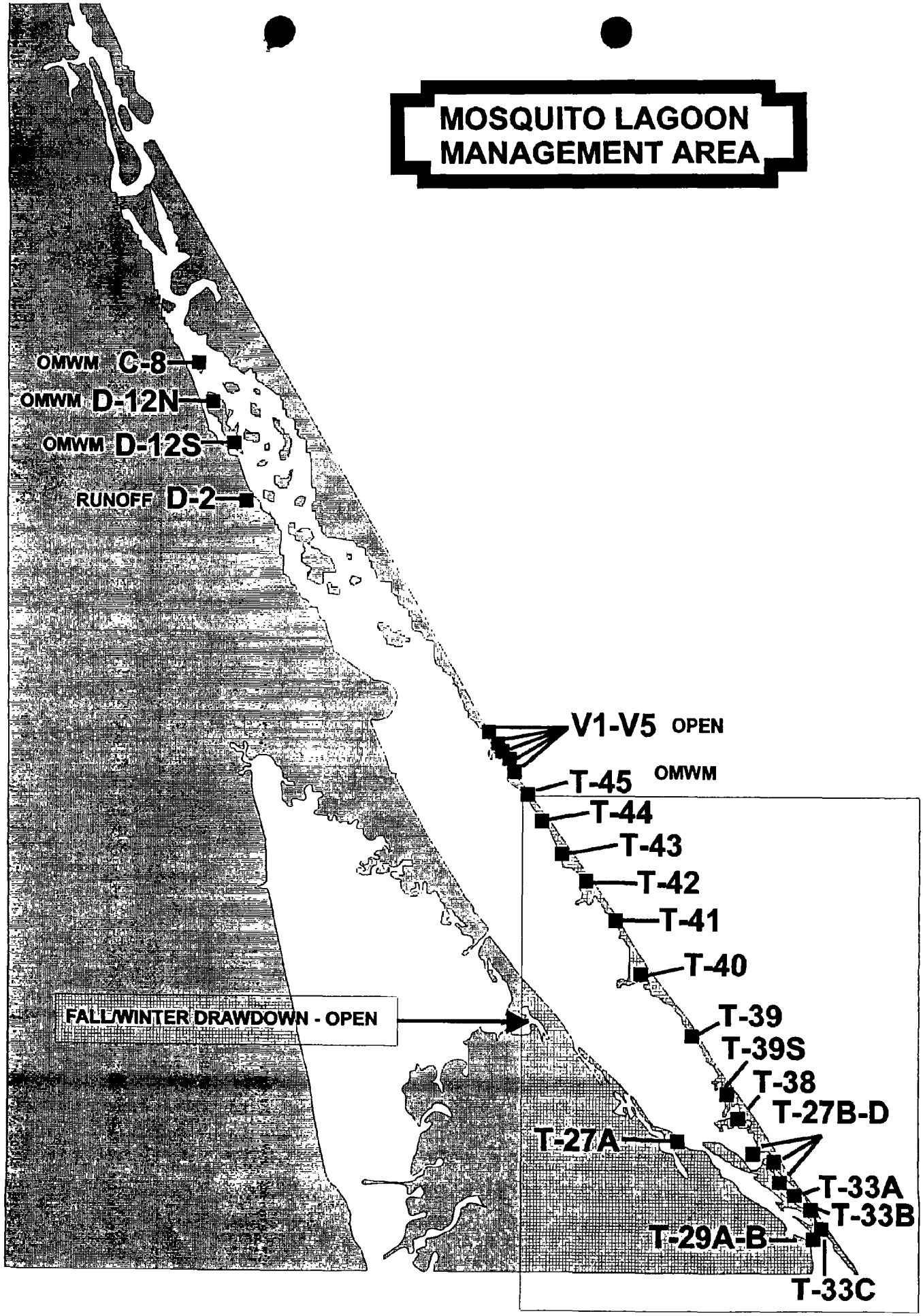
Impoundments V1 to V5. - These relatively isolated and shallow impoundments are prolific mosquito producers. Additional ditches and internal culverts are needed to improve water circulation, minimize drainage, and to maintain and disperse larvivorous fish. Water circulation may also be improved with external culverts, but the shallow topography and a lack of natural conduits for water to the marsh interior severely limit the locations where the latter would be effective. With the above modifications, the impoundments can be left open all year.

Impoundment T-45. - This impoundment can also be left open all year if more ditches are added for mosquito control.

Impoundments T-44 to T-38. - This and the next group of impoundments form the core of the migratory bird/waterfowl management sites for this area. As such, management of these impoundments should consist of a mix of fall/winter drawdown, and open year round, with variations as needed for exotic control, sediment oxidation, etc. As mentioned in the general comments, flexibility is the key for successful management of these impoundments; specific schedules and timetables will have to be determined on a year-by-year basis, depending upon water levels, weather, marsh conditions, etc. Impoundment T-39S has been permitted for breaching by NASA, and others could conceivably also be breached in the future. More culverts are needed in the non-breached impoundments in this block for efficient water management.

Impoundments T-33C to T-27A. - Management as above. A high priority for this group is the installation of a pump to allow

efficient manipulation of water levels. One large (36-inch) pump installed at impoundment T-27A would allow proper control of water levels in the whole series of impoundments from T-27A to T-29B. Additional internal culverts (one 36-inch culvert each) connecting T-33A, T-33B, T-29A, and T-29B would extend the coverage of the pump to the T-33 group thus allowing proper management of 3,932.5 acres (1,573 ha) of prime overwintering habitat. In addition, pump installation will probably result in a longer open period for these marshes because managers will not have to depend upon tidal and rainfall trapping for flooding the area. Installation of the pump and culverts is considered one of the highest priorities on a lagoon-wide basis.


MOSQUITO LAGOON
MANAGEMENT AREA
OMWM C-8
OMWM D-12N
OMWM D-12S
RUNOFF D-2
V1-V5 OPEN
T-45 OMWM
T-44
T-43
T-42
T-41
T-40
T-39
T-39S
T-38
T-27B-D
T-27A
T-33A
T-33B
T-29A-B
T-33C
FALL/WINTER DRAWDOWN - OPEN

H. CONCLUSION

The management strategies presented above represent the best compromise among many conflicting needs for these Indian River Lagoon marshes. Whenever possible, we have tried to promote enhancement of the marsh-lagoon connection, but we have also tried to inject some variety in the management strategies to assure as wide a range of benefits as possible.

The strategies presented for some impoundments are quite specific and need little modification, while others are more general and will require development of site-specific plans before they are implemented. This reflects not only the differing levels of knowledge available on the various marshes, but also the need to maintain flexibility in the way that the strategies are implemented at certain locations.

We consider this document as a flexible tool for management. In the future changes may be needed in response to new problems and opportunities. Changes may also be desirable as our knowledge on the structure and function of these marshes increases due to new research and increased management experience, and as conditions along the lagoon change as a consequence of man's activities, both positive and negative.

I. APPENDICES

A. SOMM Membership.

B. Special Interest Groups.

APPENDIX A. SOMM MEMBERSHIP.

Mr. Brian Barnett
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Mr. Kalani Cairns
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Chief, Fishery Management & Assistance Serv.
Fl. Dept. of Environmental Protection
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Tallahassee, FL 32399-3000
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Mr. Wendell Metzen
U.S. Fish and Wildlife Service
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Mr. William Opp
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Mr. Robert Repenning
Fl. Department of Environmental Protection
Division of State Lands
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Suites B & C
Bokeelia, FL 33922-0591
Phone: 813-283-2929

Dr. Jorge Rey
University of Florida - IFAS
Florida Medical Entomology Laboratory
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Vero Beach, FL 32962
Phone: 407-778-7200

Mr. Scott Taylor
Brevard Mosquito Control Dist.
2870 Greenbroke St.
Palm Bay, FL 32905
Phone 407-952-6322

Mr. Mark Thompson
National Marine Fisheries Service
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Panama City, FL 32408
Phone: 904-234-5061

Dr. Robert Virnstein
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32078-1429
Phone: 904-329-4500

APPENDIX B. SPECIAL INTEREST GROUPS CONTACTED

(* = oral presentation given)

Barrier Island Preservation Society - Melbourne, Fl.

Environmental Learning Center - Vero Beach, Fl.

Florida Native Plant Society - Conractina Chapter. Melbourne, Fl.

Florida Native Plant Society - Eugenia Chapter. Vero Beach, Fl.*

Florida Native Plant Society - Martin County. Stuart, Fl.

Florida Oceanographic Society - Stuart, Fl.

Indian River Citrus League - Vero Beach, Fl.

Marine Resources Council - Melbourne, Fl.

St. Lucie Co. Audubon Society - Ft. Pierce, Fl.*

Conservation Alliance of St. Lucie County - Ft. Pierce, Fl.*

Environet of Indian River County - Vero Beach, Fl.*

Exchange Club of Indian River County Vero Beach, Fl*.

Friends of the Sebastian River - Roseland, Fl.*

Indian River Farms Water Control District - Vero Beach, Fl.*

Martin County Audubon Society - Jensen Beach, Fl.

St. Lucie River Initiative - Stuart, Fl.

Conservation Alliance of Martin County - Stuart, Fl.

Florida Audubon Society - Casselberry, Fl.

Halifax-Indian River Task Force - Daytona Beach, Fl.

Indian River Land Trust - Vero Beach, Fl.

Pelican Island Audubon Society - Vero Beach, Fl.*

Treasure Coast Environmental Coalition - Vero Beach, Fl.