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COASTAL HABITATS

An Introduction to Coastal Ecosystems
Adjacent to Outer Continental Shelf Planning Areas

A Draft Document

Prepared by Investigators and Students of

PROJECT' OCSMAPS

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Cooperative Agreement No. 14-12-0001-30114

Federal OCS Oil and Gas Activities:'
A Relative Comparison of Marine Productivity
Among the Outer Continental Shelf Planning Areas

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INTRODUCTION

The Atlantic region has more habitat diversity in coastal and continental shelf areas than either the Gulf of Mexico or the Pacific. Northern sections of the Atlantic region (along the Gulf of Maine) are rocky and incised, with great tidal range and highly productive lithophytic macro algal communities. Farther south, from Cape Elizabeth to Cape Cod, the coast is diverse and high-energy, with pocket marshes and rocky headlands interspersed among sand, gravel and cobble beaches. Productivity is relatively low in this portion of the planning region, but the beach-and-marsh stretches are important habitat for migrating and breeding birds. From Cape Cod to Long Island Sound, the coast is quieter, less rocky and there are more marshes and coastal ponds. Narragansett Bay dominates the Rhode Island coastline, and large offshore islands (Martha's Vineyard, Nantucket, Elizabeth Islands and Block Island) provide shelter to the coast and reduce wave energy onshore. The most productive habitats in this portion of the coast are marshes, beds of submerged aquatic vegetation (SAV), and coastal ponds, None of these habitats is abundant, and this coast (except for Narragansett Bay) is dominated by the relatively low productivity of sand beaches. South of Long Island, the coastline consists of primarily of exposed beaches behind which lie intensive and highly productive tidal marshes. Along the Virginia Eastern Shore, there is a transition from high-energy sand beaches to low-profile barrier beaches with wide shallows, quieter waters and finer and lighter sediments with greater concentrations of organic matter. The. section of the Atlantic coast from New Jersey to Central Florida is highly productive due to great areal extent of marshes and SAV beds, and energy and nutrient subsidies associated with river flow into the estuaries and coastal waters.

The Gulf coast proper encompasses five states: Florida, Alabama, Mississippi, Louisiana and Texas. Georgia has no coast on the Gulf, but the extensive habitats of the Suwanee drainage basin (including the Okefenokee Swamp) are characteristic of the Gulf coastal plain and contribute to coastal productivity and the unique Gulf coast flora and fauna.

Coastal habitats in this region are diverse, with tropical to subtropical communities dominating in southern portions of Florida and Texas and warm-temperate communities in the remainder of the coastal arc. South Florida from the border of the Florida straits OCS Planning Area in Florida Bay norht through the Ten Thousand Islands is dominated by highly productive mangrove islands and salt marshes. This region is of enormous ecologic importance as a "nursery" area for commercially valuable fish and shellfish and as a breeding and wintering ground for many species of birds and mammals.

The shoreline from Cape Romano north through the Tampa Bay area is a complex of sand beaches, salt marshes and mangrove swamps with few barrier islands. These coastal communities are highly productive. The coast from Anclote Keys to Apalachee Bay is composed of rugged limestone with broad, clear shallows and extensive seagrass beds and marshes. Productivity is very high, and much of the eastern Gulf production of finfish and shellfish (including shrimp, oysters and scallops) depends on shallow bottom communities in this area. The Apalachicola Delta west to Cape San Bias is a region of sandy barrier islands fronting turbid, mud-bottomed bays. With the exception of Apalachicola Bay itself, aquatic productivity is relatively low, but the area supports a large number of endangered, threatened and endemic species and disjunct populations. Coastal terrestrial communities in this sector are perhaps as diverse and valuable as any on the Gulf. Apalachicola Bay supports extensive seagrass beds, and is a highly productive habitat.

The north-central coast, from west to Cape San Bias to the Alabama-Mississippi border at Petit Bois Pass possesses the longest streches of high energy sand beach in the Gulf. Water is clear and aquatic productivity is relatively low. Coastal terrestrial habitats support a variety of endemic species and species of special concern, and the Mobile Bay area supports interesting and unique colonies of shrubby growth black mangroves. The Mississippi Delta west through Vermilion Bay is dominated by input of fresh water and terrigenous silty sediments from the Mississippi River. The coastline is predominately barrier islands with expansive marshes and swamps and beds of benthic algae and seagrasses. The area is highly productive, and supports a diversity of vertebrate species of special concern. The Stand pipe- Chernier Plain system of western Louisiana and eastern Texas is an interesting geologic and ecologic formation. The barrier coast consists of high-energy, low productivity sand beaches which shelter extensive fresh and brackish water wetlands. The latter are highly productive, and salt water intrusion is prevented by ancient cherniers (beach ridges).

The Texas barrier island system comprises the remaining coastal habitats in the Gulf region. Sandy barrier beaches are low in productivity, but they shelter enormously productve lagoons, with marshes in the northern portion of the area and sea grass beds and hypersaline algae communities in the south. Terrestrial communities of the Texas coast support a number of vertebrate species of special concern, as well as a complex of tropical species which reach the northern limit of their range in this area. Winter and resident avifaunas are diverse and abundant, with waterfowl wintering of particular importance in lagoons and shallow offshore waters.

Steep and narrow coasts throughout the Pacific region mean that aquatic communities, particularly lithophytic macro phyte communities, dominate coastal production. Hard-substrate flora form two distinct sorts of communities along the Pacific coast. Rockweed and surf grass occupy rocks in the littoral and shallow sublittoral. In deeper waters, kelp communities inhabit the clear waters on hard bottoms to depths of several hundred meters. Both of these community types are highly productive and support diverse and abundant faunas. Most research on macroalgal communities has been conducted in southern California, where the systems probably maintain maximum possible production. Nevertheless, productivity in CCAL kelp beds may be very high, up to 24,000 kg wet weight per square meter per year (Winzler and Kelly 1977). Data are not available for these systems in NCAL, but they are likely to produce at similar rates. Coastal wetlands are an historically minor component of Pacific coasts, and there sensitivity to human impacts has rendered them even less common now. Scarcity, however, increases the importance of such wetlands as exist. Thus the valuable anadromous finfisheries of NCAL and ORWA depend on estuaries, and nursery effects of estuaries along the entire coast are magnified by the small area of sheltered littoral coast.

Alaska's coast includes virtually every morphology and habitat type common to the U. S., except for coral reefs and mangrove swamps. In addition, the peat permafrost bluffs, tundra wetlands, and sea ice of the Arctic and sub-Arctic are unique in the nation. The abundances of marine mammals, sea birds, waterfowl, and shorebirds in portions of the Bering Sea and Gulf of Alaska are without parallel in the U.S. and in most of the world. Many thousands of kilometers of rocky shore and shelf support highly productive kelps and macroalgae. The standing stock of kelp on Alaska's Pacific shore alone has been estimated at more than 10 million tons. Marine vascular plants, especially eelgrass, are also important to primary production in Alaskan coastal waters. There are immense areas of coastal wetlands in Alaska, most notably the Copper-Bering River and Yukon-Kushokwim River Deltas.

NORTH ATLANTIC

COASTAL HABITATS

The coastal portion of the North Atlantic OCS Planning Area extends from the Canadian border to Buzzards Bay south of Cape Cod, Massachusetts. The region contains a diverse array of ecological features characteristic of a glaciated coastline.

Northernmost portions of the region are characterized by a rugged, rocky shoreline with many deep, narrow inlets and nearshore islands, Tidal current velocities are high and numerous rives and streams flow into the coastal waters, creating a variety of estuarine and wetland habitats. Submerged aquatic vegetation beds, dominated by Zostera marina and Ruppia maritima occur in sheltered embayments of New Hampshire (Nelson 1981). Estuarine basins consist mainly of submerged river valleys with unmodified mouths and there are some coastal fjords. The total surface area of these estuaries is approximately 155,815 km^{-2} (Lynch et al. 1976). A succession of rocky shores with narrow sandy beaches occurs between estuarine areas.

The southernmost NATL coast includes the sand beach peninsula of Cape Cod. The region also possesses large bays and sounds, with coastal islands west and southeast of the Cape itself. SAV is found in sheltered embayments of the southern coast.

Representative productivity estimates for NATL marshes are listed in Table 7. Daily production rates for Zostera marina. SAV beds have been estimated at 0.4 to 2.9 gC m^{-2} da^{-1} (Conover 1968) and 2.5 to 5.4 g dry weight m^{-2} da^{-1} (Dennison and Al berte 1982). Much of our knowledge of pattern and process in coastal marshes is based on research conducted in coastal marshes is based on research conducted in NATL estuaries (e.g. Nixon an Oviatt 1973, Valiela et al. 1978, Woodwell et al. 1977). However, the limited extent of tidal salt marshes in the NATL Planning Area reduces their importance to functioning of the whole coupled coastal ecosystem (Table 8). Indeed, Nixon (1980) in an extensive review. could find no evidence of the much-touted “nursery” effect of estuarine area on coastal fish production in any east or gulf coast region, and the low proportion of marsh in NATL may be expected to reduce their importance even as wildlife habitat. The NATL coast may be divided into three major zones based on shoreline morphology and characteristic flora and fauna. The northernmost zone is the Gulf of Maine coast north of Cape Elizabeth. This region is distinquished by rocky, fjord-like, incised coastline with many bays, estuaries, rocky sea fronts and offshore islands. Proximity to the Bay of Fundy results in some of the greatest tidal ranges (up to 7 meters) in the United States. Tidal range decreases southward. Passamaquoddy Bay tides often exceed 6 meters, while south of Bar Harbor the normal range is approximately 3,'7 meters. Marshes and tidal flats are not abundant in this zone, but the great tidal range and rugged coast provide habitats for numerous intertidal communities in rocky tide pools. Important intertidal algae in these communities include Irish moss (Chondrus crispis), rockweed (Ascophyllum nodosum), and Fucus species. The latter two genera are particularly abundant on the rock coast of northern and central Maine. In suitable habitat. of stable rocky substrate, mean density of fucoids is at least 8.0 kg fresh weight m^{-2}. Primary production of such fucoid mats is estimated at 0.75 kg C m^{-2} yr^{-1} (Topinka et al. 1981), which may be a low estimate because of assumption of only one biomass turnover per year. However, this estimated productivity value is similar to that. reported for fucoid communities in Nova Scota (Westlake 1963) and west coast macroalgal mats (Littler and Murray 1974). In the faunal community of fucoid and other rock habitats, mussels (Mytilus edulus) often abound, supporting the only significant commercial harvest of this species in the United States. Several rivers in Maine constitute the last significant spawning areas of Atlantic salmon (Salmo salar) and shortnose sturgeon (Acipenser_berevirostris). Lowlands, bays and islands represent southern breeding limits for typically northern gulls, terns, oceanic birds, and sea ducks, Moosehorn National Wildlife Refuge is an important. breeding refuge for razorbill auk and common eider.

The second coastal zone extends from Cape Elizabeth to Cape Cod. This is a diverse and high energy coastline with embayments and estuaries, but the area is not as dissected or rocky as the northernmost zone. Marshes are more extensive than in the north, but are still limited in aerial extent and quantitative importance. The coast consists of a succession of high-energy gravel or coarse sand pocket beaches and rocky shores. Plum Island, near the mouth of the Merrimac River, is the first major barrier island south of the Canadian border-. Cape Ann itself is dominated by scattered rocky headlands, Fine sand beaches occur south of Cape Ann, and are relatively narrow. Populations of nearshore aquatic species in this zone have been reduced by river control measures and urbanization. However, extensive shellfish beds remain a significant resource (Nelson 1981). Sea, shore and wading birds breed throughout this zone, but are susceptible to disturbance associated with increasing human use,

The third recognizable coastal zone in NATL extends along the eastern and southern shore of Cape Cod to the planning area boundary at the mouth of Buzzards Bay. This area encompasses several large offshore islands (Martha's Vineyard, Nantucket, Elizabeth Islands), barrier beaches, bays and drowned river valleys. Sandy beaches are relatively narrow along the eastern and southern portions of Cape cod with well developed dune systems landward of the barrier beaches. The base of the Cape and the area around Buzzards Bay is a spatial mix of beaches, low rocky headlands and small and well protected marshes and estuarine ponds. This coastal area lies in a transition between the cold waters of the Labrador Current which dominates the North Atlantic Planning Area and the Gulf Stream which dominates surface waters of the Middle Atlantic Planning Area. An offshore temperature gradient extends eastward from Monomoy Island between the two currents during mid-June to late-September, effectively separating the marine biota of the NATL and MATL Planning Areas.

NATL Coastal Habitats

Total coastal production in NATL is probably dominated by fucoid algae and other hard-substrate communities. Of approximately 3,740 miles of shoreline in Maine, New Hampshire and Massachusetts, 2,440 is rock substrate (National Research Council 1982). Highly productive fucoid communities dominate this habitat. Remaining shoreline in northern New England consists primarily of open sand or unconsolidated sedimentsing and of marsh area (relatively productive habitat) to ocean coastline (beaches and other relatively unproductive habitats) is approximately 0.07 (National Research Council 1982), lowest for any region of the United States except the Pacific northwest. Thus, fucoid communities of the rocky intertidal are the sole important productive communities of this coast.

Table 7. Representative productivity estimates for NATL salt marsh ecosystems (see references for methods utilized).

Location	Dominant angiosperm	Production	Reference
Maine (Bar Harbor)	*Juncus gerardi* [CB][1]	40272	Linthurst and Reimold (1978)
	Juncus gerardi [HMI	616[2]	
	Spartina alterniflora [CB]	1602[2]	Linthurst and Reimold (1978)
	Spartina alterniflora [HM]	1611[2]	
	Spartina patens	5833[2]	Linthurst and Reimold (1978)
Massachusetts (Parker R. NWR)	*Spartina alterniflora* [tall]	12563	Ruber *et al.* (1981)
	Spartina alterniflora [dwarf]	408[3]	" "
	Spartina patens	8133	Ruber *et al.* (1981)
	Distichlis spicata	757[3]	Ruber *et al.* (1981)
	Juncus gerardi	3393	Ruber *et al.* (1981)
	Salicornia europaea	2073	Ruber *et al.* (1981)

[1] CB = creek bank; HM = high marsh

[2] $g \cdot m^{-2} \cdot yr^{-1}$

[3] g dry wt $\cdot m^{-2} \cdot yr^{-1}$

Table 8. Comparison of biophysical areas among regions of the United States coast. (National Research Council 1982),

	North Atlantic	Middle Atlantic	Chesapeake Bay	South Atlantic	Caribbean
Ocean coastline (mi)	1,358	1,114	11.3	817	1,542
Tidal shoreline (mi)	4,419	7,992	5,469	9,793	1,417
Estuarine water area (mi^2)	3,401	5,130	4,554	1.911	711
Marsh area (mi^2)	97.6	601.1	595	2,267	616.4
Coastal counties area (mi^2)	11,177	19,237	13,859	24,839	9,869
Descriptive ratios					
Tidal shoreline/ocean coastline	1.1	6.2	408.0	11.0	1.1
Estuarine water area/ocean coastline	2.6	4.0	400.0	4.9	0.46
Estuarine water area/tidal shoreline	0.17	0.64	0.83	0.41	0.21
Marsh area/ocean coastline	0.01	0.47	53.0	2.8	0,40
Marsh area/tidal shoreline	0.01	0.08	0.11	0.23	0.18

	Gulf of Mexico	Pacific South-west	Pacific North-west	Alaska	Pacific Islands	Total
Ocean coastline (mi)	2,270	1,1*4	669	14,899	1,194	25,230
Tidal shoreline (mi)	15,476	3,060	4,793	33,904	1,326	89,571
Estuarine water area (mi^2)	10,944	799	1,946	14,353	15	45,832
Marsh area (mi^2)	8,427	151	44.5	a	15	12,841
Coastal counties area (mi^2)	48,151	31,168	42,768	114,41>	6,703	552,184
Descriptive ratios						
Tidal shoreline/ocean coastline	6.8	2.6	7.2	2.3	1.1	3.6
Estuarine water area/ocean coastline	4.8	0,67	2.9	0.96	0.01	1.8
Estuarine water area/tidal shoreline	0.71	0.26	0.41	0.42	0.01	0.5
Marsh area/ocean coastline	1.7	0.16	0.07	--	0,01	0.5
Marsh area/tidal shoreline	0.54	0.06	0.01	--	0,01	0.1

[a] No data.

SOURCE: Brokaw 1978.

MID-ATLANTIC

COASTAL HABITATS AND COMMUNITIES

The coastal environment of the Mid-Atlantic OCS Planning Area extends from Connecticut and Long Island Sound to the Pamlico barrier island-sound complex of North Carolina. The region is dominated by large estuaries (Long Island Sound, Hudson River, Raritan Bay, Delaware River/Bay, and Chesapeake Bay), major barrier island-sound complexes, and extensive coastal marshes in quiet estuarine and barrier lagoon environments. The northern section (New York Bight, and New Jersey, Delaware, and Maryland Atlantic coasts) consists of numerous high-energy sandy beaches, The Virginia Eastern Shore marks the transition to low-profile barrier islands and beach dune systems more typical of the North Carolina Outer Banks.

Expansive monotypic marine Spartina alterniflora marshes cut by deep dendritic channels are common behind the barrier islands of New Jersey and Virginia. The large brackish sounds of North Carolina are only minimally affected by the lunar tidal cycles of the Atlantic Ocean and as a result contain large areas of irregularly flooded Juncus marshes characteristic of low-tidal-energy environments. Two large estuarine embayments, the Delaware and Chesapeake Bays, possess extensive marshes along their shores; these marshes range from virtually fresh through brackish to salt, depending on their location and influence of coastal runoff. The rivers, bays, and inlets of the MATL are surrounded by highly productive forests and non-forested wetlands,

The majority of the terrestrial habitats in the MATL consist of oak and pine forests, interspersed with locally important farmlands and major urban areas. Approximately 300 special land-use areas have been identified, including natural, historical, archeological, recreational, and multiple- use areas. Many of these are significant natural areas; they range from remote islands (important as seabird nesting sites) to managed hunting areas. Numerous federal, state, and privately-owned wildlife refuges have been established as important sanctuaries for the region's resident and migratory wildlife.

Aquatic organisms of the MATL are both abundant and diverse due to the presence of extensive and highly productive estuaries and marshes. The Chesapeake Bay is the single most important environment supporting the coastal fishery. For example, the total Bay shellfish harvest in 1977 (302 x 10^3 metric tons) accounted for 92% of the total MATL fishery (see Finfish and Shellfish, MATL, this Report). The dominating influence of the Bay on commercial harvests of finfish and shellfish must be noted even though this is not strictly an OCS environment.

Salt marshes of the MATL are similar to those found in the NATL. A transition occurs in New Jersey and Delaware where there is a subtle shift from New England-type Spartina alterniflora and S. patens meadows hacked by Juncus gerardi to marshes more characteristic of the South Atlantic and Gulf coasts dominated by S. alterniflora or Juncus romeria nus.

MATL Coastal Habitats

New Jersey marsh communities are dominated by S. alterniflora short form ("SAS"). Maryland marshes contain greater areas of S. patens (more similar to New England marshes). A transition to mono-specific stands of S. alterniflora short. ("SAS") and tall ("SAT") forms occurs on the seaward side of the Virginia Eastern Shore, while extensive areas of J. romerianus dominate Bay-side Virginia and North Carolina tidewater marshes.

MATL S. alterniflora communities exhibit great variation in above-ground average production (Table 10). Reported rates for New *York* and New Jersey marshes (444 -1700g dry $wt \cdot m^{-2} \cdot yr^{-1}$) are comparable to those of the Delmarva Peninsula (362-1207g dry $wt \cdot m^{-2} \cdot yr^{-1}$) {Turner 1976; Sugihara et al. 1979). Above-ground production for "SAS" S. alterniflora (444-592 g dry $wt \cdot m^{-2} \cdot yr^{-1}$) and meadow grasses {s. patens and Distichlis spicata; 360-805 g dry $wt \cdot m^{-2} \cdot yr^{-1}$) are considerably lower than that of "SAT" S. alterniflora (735-1700g dry $wt \cdot m^{-2} \cdot yr^{-1}$.)

The Center for Coastal and Environmental Studies (CCES) of Rutgers University conducted a comprehensive productiviy and food chain trophodynamics study of the Manahawkin salt marsh community in New Jersey (Sugihara et al. 1979). This study provides detailed information on production of several components of the ecosystem, including evaluation of both above- and below-ground production of marsh macrophytes (Table 11). Estimates of below-ground production were several times greater than for above-ground. Smith et al. (1979) continued the analysis, focusing on short-form S. alterniflora ("SAS"). The highly stable "SAS" community in Manahawkin marshes was found to be characterized by high annual primary production, dense growth habit, and root longevity, Total annual net primary production was estimated as 28 metric tons.haul, of which 23 metric $tons \cdot ha^{-1}$ was below-ground. This estimate is similar to that of the freshwater marsh annual Zizania aquatica (25 metric $tons \cdot ha^{-1}$; Good and Good 1975), although in the latter the bulk of the production (16 metric $tons \cdot ha^{-1}$) is above-ground.

Such studies indicate that annual energy and carbon fixation by short-form S. alterniflora can provide a large flux within estuarine ecosystems (with below-ground production and decomposition acting as a major sink), thus constituting' a vita] link in coastal food chains.

Atlantic SAV beds are usuaally dominated by Zostera marina (eelgrass) and Ruppia maritima. In the MATL, SAV occurs in sheltered areas of Long Island and in rimming bays or sounds created by the barrier islands on the southern shores of Long Island and New Jersey. The SAV beds of Chincoteague Bay (MD) have declined markedly during the past 25 years, apparently in parallel with the decline of extensive beds in the Chesapeake Bay (EPA 1983). Relatively large beds still occur on Lhe southeastern shore of the Chesapeake off Church Neck, in Hungar's Creek, and in 'rangier Sound (Murray 1983). The northern sounds of North Carolina are dominated by a mixture of freshwater angiosperms (i. e., Myriophyllum specatum and Potomogeton pectinatus) (Davis and Carey 1981) and brackish water Zostera marina), Further south in Pamlico Sound are more extensive areas of Zostera and Ruppia (Peterson and Peterson 1979).

MATL Coastal Habitats

Analysis of SAV productivity was a part of the extensive salt marsh ecosystem study of Manahawkin (Little Egg Harbor), New Jersey, conducted by Rutgers University (Sugihara et al. 1979). One salt marsh pond in this ecosystem contained Ruppia maritima and associated green algae (Enteromorpha calthrata and Cladophora. Maximum observed biomass (85-127g dry wt·m^{-2}) were similar to those from other NATL and MATL habitats. Average net annual production of Ruppia was estimated as 79 kcal·m^{-2}·yr^{-1}, a value low in comparison with other marine submerged aquatics. However, evaluation of community metabolism of this and other permanent salt ponds characteristic of New Jersey yielded high average production rates (2g C·m^{-2}·da^{-1}). It is believed that the high production reflects a significant contribution from the associated algae.

Benthic and epiphytic microalgae can also make significant contributions to the overall productivity of SAV communities. Beds in the southeastern Chesapeake Bay (Vaucluse Shores) exhibited high annual gross production rates (1580g C·m^{-2}, Z. marina, 1000g C·m^{-2}, R. maritima), of which microalgae accounted for 5% and 36%, respectively, of the totals (Murray, 1983).

These observations suggest that productivity estimates based on measurements made solely on the host SAV can significantly underestimate the total primary production of these communities.

Freshwater tidal wetlands contain a much greater diversity of emergent macrophyte species than brackish or salt marshes. Under norms] conditions a combination of 12 or more emergent macrophytes dominate these habitats. Although most species are widespread, distinct associations do occur (Figure 2). Net primary production in freshwater tidal wetlands of the MATL coast ranges 1000 -3500 g·m^{-2}; in some wetlands primary production may exceed 4000g·m^{-2} (Whigham et al. 1978; Simpson et al. 1983). It is likely that actual net primary production for these tidal wetlands is higher than reported values indicate because few measurements include below-ground production or estimates of leaf turnover. Algal production in these environments contributes less than 1% of net annual production, far less than the 30% estimated for algal components of salt marshes.

New Jersey contains a relatively high proportion of all freshwater tidal wetlands along the Atlantic and Gulf coasts, i.e., 100,000 -140,000ha of a total of 500,000 -1,000, 000ha. Peak above-ground standing crop estimates for New Jersey range from 566 to 2312g·m^{-2} (Whigham et al. 1978). Communities dominated by Nuphar advena, Peltandra virginica, and other species having little structural tissue typically have standing crops less than 1000:;.in·^{7}-, whereas Typha sp. and Lythrum salicaria, with abundant structural material, may exceed 2000g·m^{-2}.

Table 10. Comparison of net above-ground production estimates for several Atlantic coastal salt marshes (compiled by Sugihara et al. 1979).

Vegetation type	Net above-ground production (g dry wt·m^{-2}·yr^{-1})	Date	Location
S. alterniflora ("SAT")	027	1969	Long Island, NY
	1700	1972	Great Bay, NJ
	850	1977	Great Egg Harbor, NJ
	825	1973	Manahawkin, NJ
S. alterniflora ("SAS")	508	1969	Long Island, NY
	590	1972	Great Bay, NJ
	558	1973	MD and VA
	574	1973	Manahawkin, NJ
S. alterniflora (all forms)	300	1965	Cape May, NJ
	1332	1969	Virginia
	427-558	1973	MD and VA
	362-573	1976	Virginia
S. patens	1305	1969	Virginia
	550	1972	Great Bay, NJ
	618	1973	Manahawkin, NJ
Distichlis spicata	360	1969	Virginia
	670	1972	Great Bay, NJ
	644	1973	Manahawkin, NJ

Table 11. Net annual production estimates, 1974-75, for above- and below-ground components of six communities in Manahawkin marshes, NJ (from Sugihara et al. 1979).

Vegetation type	Net annual production (g dry wt·m^{-2}) Above-ground	Below-ground	Total	Root:shoot ratio
"SAS"	520	2400	2920	5.24:1
"SAS"	360	3590	3590	10.15:1
S. patens	590	3270	3860	5.58:1
S. atens	460	2250	2710	5.71:1
"SAT"	640	3330	3970	4.53:1
Distichlis spicata	620	2780	3400	4.50:1

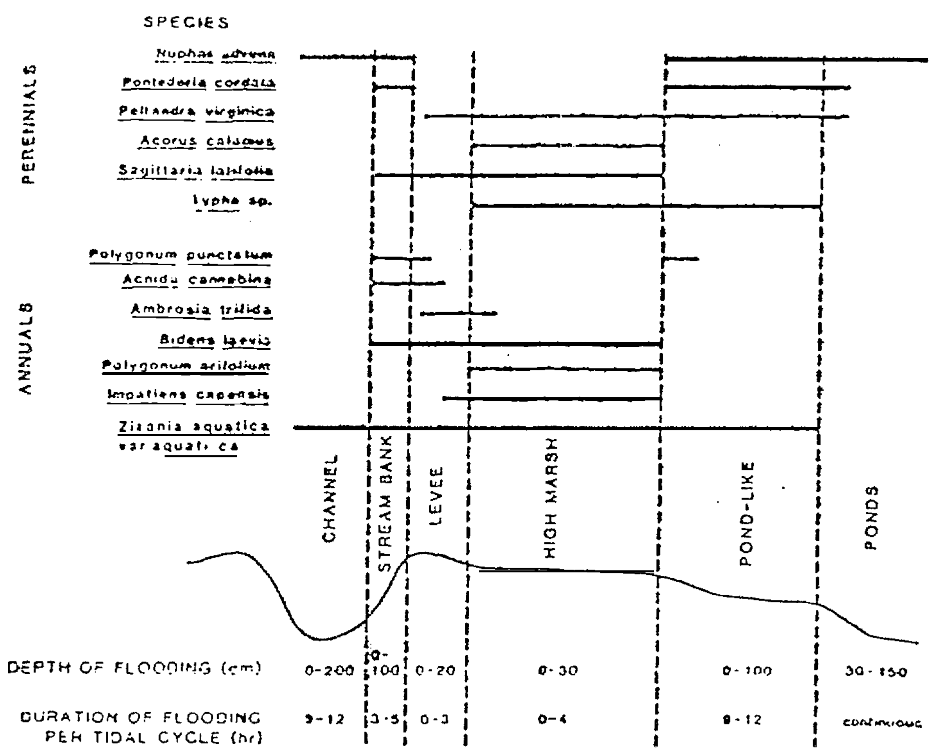

Figure 2. Diagram of major habitats found in freshwater tidal wetlands. Distribution patterns of dominant species, duration and depth of flooding are also shown (from various sources, compiled by Simpson et al. 1983).

SOUTH ATLANTIC

COASTAL HABITATS

The coastal environment of the SATL Planning Area, includes a diversity of habitats: barrier islands, salt marshes, estuaries, lagoons, and coastal uplands (Lynch et al. 1976). Although estuaries are not as extensive as those of the MATL, they occur in greater numbers and contain valuable marshes with numerous tidal creeks, sounds, and alga-rich mudflats. The estuaries and lagoons together support commercially important populations of bay scallops, hard clams, shrimp, blue crab, and menhaden,

Inland areas consist of pine forests, scattered savannah grassland, and upland hardwoods, Bald cypress and water tupelo dominate riverine communities. The coastal habitats of the SATL are valuable to regional wildlife; the Planning Area contains more than 160 special land use areas, including several National Wildlife Refuges and Wildlife Management Areas, state parks and preserves, and twelve aquatic preserves in Florida (Beccasio et al 1980). The diversity of wildlife includes breeding populations of herons, egrets, ibises, rails, gulls, terns, ducks, raptors, and deer, and large wintering concentrations of waterfowl. Coastal habitats of the entire region support the following endangered species: bald eagle (Haliaeetus luecocephalus), brown pelican (Pelicanus occidentals), peregrine falcon (Falco peregrinus) (migrant and winter), red-cockaded woodpecker (Dendrocopos borealis), sea turtles (five species), American alligator (Alligator mississippiensis), and migrating whales (five species) (Lynch et al. 1976; Baccasio et al.). Several critical habitats for sea turtles, the West Indian manatee, and the American alligator exist in the region.

Three major coastal morphologies are included in the SATL, each distinguished by a different barrier island system. The first region, encompassing Core, Back, and Bogue Sounds, is a continuation of the large Pamlico barrier island-brackish sound complex of the MATL. It is characterized by long islands with wide sandy beaches which protect marine lagoons rimmed by tidal marshes and numerous seagrass (Zostera-Halodule) beds.

The second coastal region (Sea Islands region) extends along the southern North Carolina coast (Onslow Bay) where tidal amplitude increases from 1.0m to 2-4.0m. The resulting "mesotidal" coastline is characterized by short barrier islands with wide white sand beaches fronting large bands of salt marshes drained by dendritic creeks. Immediately adjacent to the numerous inlets are narrow estuarine bays and large expanses of tidal marsh dominated by Spartina alterniflora with Juncus romerianus found at interfaces between marsh and upland. This system is especially well developed behind the irregularity shaped Sea Islands of South Carolina and Georgia. Two distinct morphological forms of S. alterniflora are especially well defined in these marshes. The tall form occurs along tidal creek banks and levees; the medium/short form is found in high marsh (Giurgevich and Dunn 1982). Sounds and bays of this region receive considerable freshwater input. and silt deposition from coastal plain rivers -- the resulting increase in turbidity virtually eliminates seagrass populations.

SATL Coastal Habitats

Mesotidal coastline gives way to the third coastal morphology with little transition at the mouth of the St. John's River in northern Florida. This region then extends 480 km south to Ft. Lauderdale. It is characterized by a series of long, narrow barrier islands with high energy sand beaches occasionally broken by narrow inlets. The barrier islands front a long system of narrow high-salinity lagoons (through which the Intra-coastal Waterway passes) with productive estuarine marshes and riverine or mangrove swamps landward. Cape Canaveral is a transition region where submerged aquatic vegetation (SAV) (Syringodium, Halophila, Halodule, Thalassia), found growing in lagoons and protected nearshore areas, becomes a component of the seaward coastal habitat. Significant stands of mangrove (particularly black mangrove, Avicenna germinans, south of 30°N) also grow in marshes and swamps.

SATL barrier island beaches are extremely important as avifauna (colonial birds and rookeries) and sea turtle nesting sites. Critical habitats for loggerhead turtles occur on beaches of each state in the region. However, few studies have been performed on barrier island productivity and estimates must be based on beach infauna and vegetation data from studies outside the region, In contrast, there are several studies of marsh productivity in the SATL.

The North Carolina sounds (Core, Back, and Bogue) possess shallow marine lagoons (Beccasio et al. 1980) in contrast to the brackish lagoons directly to the north, and contain intertidal sand flats with abundant SAV composed of Zostera marina and Halodule wrightii in pure or mixed stands. Estimates of annual net primary production made for these SAV communities and the S. alterniflora marshes behind Bogue Sound are summarized in Table 11. Seagrass beds contributed relatively high productivity values [330-340 $gC \cdot m^{-2} \cdot yr^{-1}$ for Zostera, 73 $gC \cdot m^{-2} \cdot yr^{-1}$ for Zostera epiphytes, and 73-300 $gC \cdot m^{-2} \cdot yr^{-1}$ for mixed H. wrightii and brown algae (Ectocarpus); Penhale 1977]. S. alterniflora production for all height forms ranged 300-2200 g dry $wt \cdot m^{-2} \cdot yr^{-1}$ and total Spartina marsh averaged 470 $gC \cdot m^{-2} \cdot yr^{-1}$.

Data compiled by Bigelow (1977) for aerial coverage and relative importance of each type of primary producer in total production of entire estuaries indicates that phytoplankton account for 49%, S. alterniflora 42%, benthic microalgae 7.4%, and Zostera and epiphytes only 1.4%. Nevertheless, the SAV beds are vital for the bay scallop (Argopecten irradians) and hard clam (Mercenaria mercenara) growth and reproduction. Core through Back Sounds support an important scallop commercial fishery. In addition, the lower salinity marshes and SAV areas are important nurseries for juvenile pink and brown shrimp, indirectly supporting an industry which is the most valuable commercial fishery in North Carolina.

The barrier islands of the Sea Islands region protect Spartina tidal marshes which are some of the most expansive in the world (Lynch et al. 1976). The productivities of these marshes are comparable to marsh areas in the CGUL (Louisiana and Mississippi) (Turner 1976). The region is characterized by low-lying Spartina marshes with a vast network of dendritic creeks, deep channels, and productive areas of silty intertidal flats.

Productivity of tall-form Spartina alterniflora, S. patens, and Juncus of Sapelo Island and Altamaha and Duplin River marshes has been studied intensively for the past 25 years by scientists of the Georgia Marine Institute. Several studies involving different methods have produced average values with a range of 973-3300 gC dry wt$\cdot$m$^{-2}\cdot$yr^{-1} as summarized by Turner (1976) and Gallagher et al. (1980). Recent estimates for total (above- and below-ground) Spartina and Juncus production at Sapelo Island determined by two independent methods (Gallagher et al. 1980) have yielded a very high range of values for net primary productivity (g dry wt$\cdot$m$^{-2}\cdot$yr^{-1}):

	Harvest method	CO_2 method
Tall Spartina	5845	15804
Short Spartina	3353	3359
Juncus	5501	7542

These values indicate high productivity and efficiency of marsh angiosperms in the Sea Island region -- highest for the Atlantic Coast.

Marshes and riverine swamps extending southward in Florida behind long barrier islands and lagoons are more protected (and have greater species diversity) but not as extensive as those of the Sea Islands region. Annual productivity of marshes experiencing high tidal amplitude (1.04m) is relatively high, with reported estimates of 1201-1208 g dry wt$\cdot$m$^{-2}\cdot$yr^{-1} in marshes near latitude 30°N. Further south, in northern Indian River above Cape Canaveral (at 28°50'N, where tidal amplitude has decreased to 0.76m), average S. alterniflora marsh production has been estimated at 721 g dry wt$\cdot$m$^{-2}\cdot$yr^{-1} (Turner 1976).

SAV, a mixture of Syringodium filiform, Halodule wrightii, Thalassia, Halophila, and Diplanthera, becomes a feature in the Indian River south of Mosquito Shoals. Here Gilbert and Clark (1.981) measured monthly biomass variations ranging between 5-45 g dry wt$\cdot$m^{-2} with maximum standing crops occurring in September. Virnstein (1982) demonstrated rapid turnover, includor Halodule wrightii with comparable standing crops (28 g dry wt$\cdot$m^{-2}). Although biomass and productivity of SAV in this area are relatively low, the grasses remain a vital food source for sea turtles and manatees and are important in maintaining critical habitat for these endangered species.

Benthic Habitats

Epifaunal megabenthos sampled by photographic sled at stations inshore of the 200 meter isobath indicate frequent occurence of corals, urchins and crinoids on South Atlantic bottoms (South Carolina Marine Resources Research Institute 1982). Quantitative grab and suction dredge samples at the same stations indicate numerical dominance by polychaetes, molluscs and amphipods. Depth and season played no role in community structure determination. Biomass was dominated by cnidaria, molluscs and echinoderms, although shell weights may have been included in measurements, Total macrofaunal biomass was not reported quantitatively, but on a comparative basis, stations in the 26-45 meter depth ranges were greater than shallower (16-25 meter) or deeper (46-100 meter) stations (South Carolina Marine Resources Research Institute 1982).

Sand bottom stations off Sapelo Island, Georgia, showed dominance changes with depth. Stations four to seven kilometers offshore were dominated by spionid polychaetes, tellinoid bivalves and a cumacean. A single station ten kilometers offshore was dominated by ascideans, amphipods and glycerid polychaetes. Number of macrofauna species recovered (1mm mes seine) w-as 51 to 107 individuals per 1.2111^2 at shallow stations and 50 to 96 individuals per m2 at the deep station. Number of macrofauna individuals per meter^2 ranged from 473 to 20,584 at shallow stations and 258 to 1,238 at deep stations (Frankenberg and Leiper 1977).

Productivity of SATL benthos has not been reported, and the region generally has not been adequately investigated from a quantitative standpoint.

Table 11. Net annual primary productivity of each major source of plant production in the Newport River estuary (compiled by Peterson and Peterson 1979),

Source of primary production	Effective area of habitat (km^2)	Productivity ($gC \cdot m^{-2} \cdot yr^{-1}$) Per unit area within its own habitat	Per unit area averaged over al I estuarine habitats
Phytop lankton	31	110	110
Spart ina altern iflora	6.2	470	94
Zostera mari na	0.3	330	3.16
Zostera epiphytes	0.3	73	0.71
Benthic microalgae	15.5	33.7	16,6

EASTERN GULF OF MEXICO

COASTAL HABITATS

The Eastern Gulf of Mexico OCS Planning Area includes the Gulf coasts of Florida and Alabama. The region spans a wide variety of coastal habitats from the coral reef and mangrove communities of south Florida (Odum et al. 1982; Lynch et al. 1976) to the barrier islands and high energy beaches typical of the northern Gulf. Bays backed by extensive salt marshes, the latter often dominated by *Juncus romerianus*, are found behind the barrier islands.

The entire EGUL includes habitat and important nursery grounds for estuarine-dependent fish and shellfish such as menhaden, penaeid shrimp, bluecrabs, oysters, spotted sea trout, croakers, mullet, snappers, red drum, pompano, flounders, and catfishes. Together, waters of the northern and central Gulf of Mexico yield the most valuable fishery (shrimps) and the largest fishery by weight (menhaden) in the U.S. (Beccasio et al. 1982). In addition, the EGUL is vitally important to migratory and wintering waterfowl and nesting wading birds (Feb.-June) such as wood stork, little blue heron, and snowy egrets. The area provides important habitat for several endangered species, including the American alligator, five species of sea turtles, Everglade kite, bald eagle, brown pelican, and other endangered birds, and the sperm whale, West Indian manatee, and Florida panther.

The EGUL can be divided into four major ecological zones on the basis of characteristic vegetation and coastal morphology. These are now considered in turn.

The South Florida region extends from the arc of the Florida Keys through the Ten Thousand Islands area to Cape Romano. Portions of this region are similar to extreme southern SATL -- mangrove and freshwater swamps, intermittent high energy beaches, barrier islands and seagrass meadows, south Florida is a unique coastal environment for the U. S., however, because it possesses certain features not found elsewhere, exposed shoreline containing a complex system of tidal creeks, mangrove swamps, and numerous small mangrove islands separated by shallow tidal lagoons and natural passes.

Many South Florida flora and fauna are unique to North America because the region represents the northern limit of many tropical species and because of the unique coastal habitats described above. The region is oft en the sole habitat and/or North American breeding location for several species, many of which have special status. These include Florida State-designated endangered species such as the Florida royal palm, Key Largo woodrat, Key Largo cotton mouse, silver rice rat, Key silverside, as well as Federally-designated endangered species such as the American crocodile and sea turtles. Florida Bay and the Ten Thousand Islands are critical habitats for the crocodile and West Indian Manatee, the latter occurring in major concentrations during the winter.

South Florida's valuable pink shrimp, spiny lobster, and stone crab fisheries also contribute to its "unique" status. In particular, Florida Bay serves as a major pink shrimp nursery area for the Tortugas grounds which yield almost 50%

of the west Florida fishery. Indeed, Florida Bay and proximal Gulf of Mexico waters have been proposed as a Tortugas Shrimp Sanctuary. In addition, nearly 97% of the Florida west coast spiny lobster fishery (90% of the total U.S. fishery) and 40% of the Florida west coast stone crab fishery (35'% of the total U.S. fishery) are landed in Florida Bay and the Keys.

The region north of the Ten Thousand Islands, between Cape Romano and Tarpon Springs represents a transition from mangrove and swamp to salt "marsh habitats. This region is characterized by barrier islands with shoreward embayments which support a variety of habitats depending upon latitude north: salt marshes (dominated by Spartina alterniflora and Juncus romerianus), freshwater swamps, or dense mangrove stands.

Southern mangrove swamps and nearby coastal waters adjoining Lee County, Charlotte Harbor, and the Peace and Myakka Rivers have been designated by Florida State as critical habitat for the West Indian manatee. Manatees concentrate in these areas during the winter. Many pink shrimp on the Sanibel Grounds (which yield approximately 30% of west Florida's commercial fishery) use the Charlotte Harbor complex of seagrass beds as nursery grounds. Loggerhead and hawksbill turtles nest on the barrier islands near Sarasota and Tampa Bay; the area (lower portion of Manatee and Little Manatee Rivers) is also critical manatee habitat (Beccasio et al. 1982).

The third zone begins north of Tampa Bay and Anclote Key where the barrier islands disappear. Above Tarpon Springs are very wide shallow areas with extensive seagrass beds (principally Thalassia testudinum). The "zero-energy" designation reflects inadequacy of both wave activity and sand supply for building barrier islands (Bittaker 1975; Beccasio et al. 1982).

The region is marked by open Gulf oyster bars, drowned Karst topography, rugged shoreline, intermittent. sand beaches, and expansive Spartina-Juncus or Juncus dominated marshes which may extend inland for several miles (Bittaker 1975; Beccasio et al. 1982), The region of tile Crystal River is the northern limit of the more restricted winter range of the West Indian manatee; this area has been designated as critical manatee habitat due to its increased winter concentrations of this endangered species. The region also contains the largest nesting colony in the EGUL Planning Area for herons, egrets, ibises, and brown pelicans (endangered) at Cedar Key National Wildlife Refuge.

Marine mammals, part. icularly bottle-nosed dolphins, may use estuaries in central Florida bounded by as breeding grounds (Caldwell and Caldwell 1973; Schmidly 1981; Fritts et al. 1983).

The exposed shoreline extending from Appalachee Bay to the Alabama border supports barrier islands of form typical of the CGUL and WGUL Planning Areas. Several bays and sounds, bordered by Spartina marshes and pine savannah, are partially enclosed by the coastal islands. The barrier islands themselves consist of relatively straight shoreline characterized by high energy beaches and well-protected dune systems. In the coastal bays, oyster and scallop beds are extensive but, because of variable water quality, seagrass beds are much less abundant than in the Zero-Energy 'Lone. Appalachicola Bay contains one of the most commercially productive estuaries along the west. Florida coast. It is also noted for its concentrations of amphibians and reptiles.

The barrier islands lengthen near the Alabama border: high energy beaches dominate in this area. The Mobile River system is a broad marsh- and mangrove swamp-covered alluvial plain. The lower Mobile estuary support-s a high standing crop of seagrass used by fish and overwintering duck populations.

Mangrove forests are well developed in southern EGUL. Four species of mangrove are native to EGUL: red mangrove, Rhizophora mangle, black mangrove, Avicenna germinans, white mangrove, Lagancularia racemosa, buttonwood, Con ocarpus erects. Black mangrove is found throughout the region; red and white mangroves occur as far north as Cedar Keys. South of Tampa Bay a coastal zonation of mangroves is evident progressing from sea toward land: red, black, white, then buttonwood (not a true mangrove, but a typical transitional species between mangrove and upland coastal forest; Humm 1973).

Mangrove forests are extremely productive, with gross primary production rates as high as 24g $C \cdot m^{-2} \cdot day^{-1}$ (Odum et al 1982). Representative estimates are summarized in Table 10.

Salt marshes occupy vast coastal areas from Tarpon Springs northward to Port St. Joe, FL. In general, these marshes exhibit zonation progressing landward from a band of Spartina alterniflora through virtually pure stands of Juncus romerianus (which covers the greatest total area of any marsh plant) to mixed meadows of S. patens and Distichlis spicata or salt barrens of Salicornia spp. (Humm 1973). Production of these marshes varies with location as well as species composition, with decreasing values typically encountered as one progresses landward across the various zones (Table 11).

Appalac hicola Bay, a very productive area, contains fresh and brackish water marsh vegetation above East Bay. These marshes comprise 14% of the total aquatic area of the Bay. Dominant vegetation consists of a mixture of bulrushes (Scirpus, spp.), cattails (Typha domingensis), saw grass (Clodium jamaicense), and brackish-water forms of cordgrass (Spartina and Juncus). Other areas of the Bay are fringed by J. romerianus with secondary concentrations of S. alterniflora. Annual estimated net production, based in part on data from Kruczynski et al. 1978, is estimated as 47,000 metric tons for the entire Bay region (Livingston 1983).

The Alabama coast contains only 25 mi^2 of salt and brackish water marshes; these are described in considerable detail by the Geological Survey of Alabama (1976) and Stout and LeLong (1981), Vegetation of these marshes is diverse and distributed into distinct zones typical of neighboring Florida ecosystems. Net productivity estimates for these marshes are included in Table 11.

The 8500 km2 of seagrasses in Florida constitute one of ,the largest SAV resources on earth, Over 90% of the SAV beds lie outside estuaries in intertidal and subtidal areas and thus are subject to influences resulting from OCS leasing activities.

The Florida beds are located primarily in two major areas (Zieman 1982). The largest (5,500 km^2) lies in the South Florida region, extending west from northern Biscayne Bay (SATL OCS Planning Area) and south from the freshwater line at Cape Sable to the Dry Tortugas. Although aerial coverage is broken in places which may vary from year to year, more than 80% of the sea bottom contains SAV on the average. As in southeast Florida (SATL), extensive SAV meadows are dominated by Thalassia testudinium (turtle grass) mixed with Halodule wrightii (shoal grass) and Syringodium filiform (manatee grass) (Zieman 1982).

Seagrass coverage north of Cape Sable decreases rapidly due to reduced salinities and increased turbidity introduced by Everglades' drainage. SAV is found only in small beds in estuaries and bays until north of Tarpon Springs, where an extensive (3000 km^2) bed forms a band approximately 16-24km wide. Major species include turtle, shoal, and manatee grasses. Widgeon grass (Ruppia maritima) occurs in estuaries and Halophila engelmanii, mixed with turtle grass, occurs from Cedar Key to Appalachee Bay in higher salinity open Gulf areas,

Seagrass communities are potentially extremely productive, but reported values vary greatly with species composition, density, season, and method of measurement. SAV beds vary so widely in density that even standing crop estimates are difficult to make over extensive areas, Estimates based on marking plants for determining subsequent grow-lb, and on uptake of $^{14}CO_2$ are usually in acceptable agreement and are believed to provide a measure of new primary production (Zieman 1982). Estimates derived from O_2 production measurements are often significantly higher and probably represent contributions from epiphytes and benthic algae to overall community production. The summaries presented in Table 12 are believed to be representative of these EGUL communities on the average, but they remain subject to all these caveats.

The Appalachicola Bay and East River system contains mixed beds of turtle, shoal, and manatee grass. In more brackish waters, Vallisneria dominates, Work by Purcell and Livingston (reported in Livingston 1983) indicates that the annual productivity of the entire Bay system may be as high as 27,000 metric tons$\cdot yr^{-1}$.

Although their productivity is extremely important., the extensive SAV meadows of the EGUL also make significant ecological contributions to the region as refuges and feeding areas, nursery grounds, and sources of exported organic matter for utilization al distant locations. SAV from the vast open beds is readily transported into the open Gulf of Mexico where it may be a substantial subsidy to local carbon and nitrogen budgets (Zieman 1982).

Table 10. Estimated annual net productivity of EGUL mangrove forests (from Odum et al. 1982).

Ecosystem	Average Production (metric tons dry $wt \cdot ha^{-1}$)
Mixed mangrove forests	46.0
Riverine mangrove forests	17.5
Basin mangrove forests	27.4
Pure red or black mangrove forests	20.5

Table 11. Annual net productivity (above-ground) estimates for EGUL salt marsh ecosystems.

Ecosystem	Dominant species	Estimate g dry wt·m^{-2}	Comments	Reference
S. Florida (Everglades NP)	J. roemerianus	181	converted from 1300 metric tons·yr^{-1} over area of 290 acres	Humm 1973
Apalachee Bay (East R., MAP 42)	J. roemerianus	949	low marsh	Kruczynski et al. 1978
		595	upper marsh	" "
		243	high marsh	" "
	S. alterniflora	700	low marsh	" "
		335	upper marsh	" "
		130	high marsh	" "
Alabama coast	J. roemerianus	333	coastal marshes	de la Cruz and Hackney 1977
	S. alterniflora	621		

Table 12. Production estimates for EGUL seagrasses and SAV communities,

Species	Region	Biomass 9 dry wt·m^{-2}	Production	Method	Reference
T. testudinum	s. Florida	500-31000 (avg.)	0.35-16 $gC \cdot m^{-2} \cdot d^{-1}$		Zieman 1982
S. filiforme	s. Florida	100-300 (avg.)	0.8-3.0 $gC \cdot m^{-2} \cdot d^{-1}$		Zieman 1982
H. wright ii	s. Florida	50-250			Zieman 1962
mixed beds	nw Florida	88-4000			Phillips 1978
T. testudinum	MAPS #40-41		1.0-1.6 $gC \cdot m^{-2} \cdot d^{-1}$	^{14}C	Bittaker 1975
			0.360 $gC \cdot m^{-2} \cdot yr^{-1}$	^{14}C	" "
T. testudinum	nw Florida		642 $gC \cdot m^{-2} \cdot yr^{-1}$	marking	Bit taker and Iverson 1976
			415 $gC \cdot m^{-2} \cdot yr^{-1}$	^{14}C	" "
mixed saline beds	n. Florida		500 $gC \cdot m^{-2} \cdot yr^{-1}$		Livingston 1983
mixed brackish beds	n, Florida		320-350 $gC \cdot m^{-2} \cdot yr^{-1}$		Livingston 1983

CENTRAL GULF OF MEXICO

COASTAL HABITAT'S

The coastal region of the Central Gulf of Mexico OCS Planning Area comprises three geographically and ecologically distinct environments:

1. barrier island complex

The eastern third of the Planning Area, from Bon Secour Bay in the east to Gulf port in the west, is composed of a chain of offshore islands with exposed beaches sheltering the waters of Mississippi Sound and an attendant complex of highly productive marshes and swamps.

2. Mississippi delta

The central third, proceeding westward from Gulf port to Blanch Bay, is composed of extensive marshes and delta islands associated with efflux of the Mississippi River.

3. coastal dunes

The western third from Blanche Bay to Sabine Lake, is characterized by narrow sand beaches and coastal dunes with extensive marsh and lake systems landward of the beachfront.

Unvegetated habitats common to all three areas include beaches and flats.

Habitats and Estimated Productivity

Exposed beaches (facing the Gulf of Mexico) are composed of sand and shell, and occur where wave energy is sufficient to rework sediments (Wicker 1980). Production of high-energy beaches on the Gulf Coast has not been evaluated, However, in situ productivity of open beaches may be expected to be lower than that of adjoining habitat types (Steele and Baird 1968). Input of organic material from more productive sheltered areas and from water column production subsidize a diversity of fauna associated with beaches and adjacent sublittoral habitats (Gallaway 1981). Subsidized secondary production may be relatively high due to favorable temperatures year-round and large quantitities of organic input. For example, oysters in the Pass Christian area may increase in size at a 1/4-inch·month^{-1} (see Ladner and Franks 1982).

Unvegetated mud, sand, or organic material flats form in sheltered areas. Most flats in CGUL are composed of mud and organic matter) and such highly subsidized sediments may be extremely productive. While production of Gulf Coast flats has not been measured, similar habitats on the Atlantic coast. have annual production rates averaging 65-200g C·m^{-2} (Pamatmat 1968, Murray 1983, Rizzo and Wetzel 1'385).

Offshore barrier islands of the eastern third of CGUL shelter extensive estuarine habitats of Mississippi Sound, At least 77 species of epiphytic and bed-forming algae occur in summer (Eleuterius 1981). Productivity of algal beds in Mississippi Sound has not been reported, but bed-forming algae in other areas are highly productive. For example, average production of kelp beds is approximately 3400g organic matter (ash-free dry wt., AFDW)$\cdot m^{-2}\cdot yr^{-1}$; of rockweeds, 750g AFDW$\cdot m^{-2}\cdot yr^{-1}$; and tropical macrophytic green algae may produce up to 4000g AFDW$\cdot m^{-2}\cdot yr^{-1}$ (Teal 1980). The last is a maximum figure; average production of Mississippi Sound macroalgal beds is undoubtable considerably less. The biota of the eastern Gulf of Mexico does have subtropical affinities (Gallaway 1981), but water clarity in this area is often poor (Beccasio et al. 1982).

Beds of submerged aquatic vegetation (SAV) occur discontinuously on sheltered bottoms of Mississippi Sound, Dominant species include turtle grass (Thalassia testudinum), shoalgrass (Halodule beaudettei), manatee grass (Cymodocea filiformis), and Gulf halophila (Halophila englemannii). Distribution and abundance of SAV beds varies annually, being reduced during years of high rainfall and river discharge and increasing when salinities increase. SAV beds are ecologically very important. They stabilize and bind sediments, support a diverse invertebrate community, provide food for waterfowl, and act as shelter and nursery grounds for commercially valuable species of fish and shellfish (Garofalo 1.982).

Reports providing production data for SAV beds in CGUL were not located, but Bittaker (1975) studied ecologically similar beds in Florida. Integrated annual production measurements from December to April ranged 150-360g $C\cdot m^{-2}\cdot yr^{-1}$. These numbers are underestimates due to low but positive unmeasured winter production. Production of individual species composing CGUL SAV beds has been measured in various subtropical areas, and ranges of 72-4000g $C\cdot m^{-2}\cdot yr^{-1}$ have been reported.

Salt marshes are found throughout CGUL, but by far the greatest areal extent of such marshes occurs in the western two-thirds of the Planning Area among the islands of the Mississippi delta and behind the beach front of the coastal dunes region (Wicker 1980). Gulf salt marshes are dominated by Spartina alterniflora, S. patens, Distichlis spicata and Juncus roemarianus (Wicker 1980, Stout and de la Cruz 1981). Such marshes support an enormous abundance and diversity of arthropods, molluscs, and vertebrates (Teal and Teal 1969). Marsh production may be exported to subsidize production in adjacent estuarine and coastal habitats. This "outselling" of matter and energy may be in part responsible for the "nursery effect." of estuaries which support propagation and growth of commercial fish species (Odum 1981).

Salt marsh production varies greatly with species composition, site characteristics, and method of measurement (de la Cruz 1974, Hopkinson et al. 1978). In general, however, the highly subsidized biotic communities of coastal salt marshes are among the most productive in lhe world. In CGUL, salt marsh production ranges 600-6000g $dw\cdot m^{-2}\cdot yr^{-1}$ (Kirby and Gosselink 1976, Hopkinson et al. 1978, Delaune et al. 1979, Stout and de la Cruz 1981).

The Mississippi delta region supports a complex of communities in habitats of reduced salinity. These biotic communities have been classified as brackish water marshes, intermediate marshes, freshwater marshes, and forested swamps (Wicker 1980). Similar communities are found behind the coastal dunes of the western third of CGUL, where the areal extent of freshwater marshes is lower and the coast is dominated by brackish and intermediate marshes [Wicker 1980).

Brackish water marshes occur where salinity averages 10-20°/₀₀ (Wicker 1980). Dominant plants are S. patens and D. spicata, and production values range 1484-6043g $dw \cdot m^{-2} \cdot yr^{-1}$ (de la Cruz 1974, Hopkinson et al. 1978).

Intermediate marshes occur in areas of low and/or variable salinity, and may develop in waters of considerably <5 to 10°/₀₀, depending on annual salinity regimes. Dominant, plant species include S. patens, Phragmites australis, and Sagittaria falcata (Wicker 1980). Production of intermediate marshes ranges 600-2330g $dw \cdot m^{-2} \cdot yr^{-1}$ (de la Cruz 1974).

Freshwater marshes occur where salinity is <5°/₀₀. Dominant plant species of these diverse and productive communities include Panicum hemitomon, S. falcata, Eleocharis sp., and Alternanthera philoxeroides (Wicker 1980). Production values for the community as a whole are not available. S. falcata produces 600-1500g $dw \cdot m^{-2} \cdot yr^{-1}$ (de la Cruz 1974, Hopkinson et al. 1978).

A particularly interesting component of the flora of the Mississippi delta is the black mangrove, Avicennia nitida. Mangroves dominant the only saline swamp community in CGUL, and comprise scattered stands on many of the coastal islands. Mangroves in this region remain shrubby (1.5-3m in height.) because of irregular freezes (Wicker 1980). Mangrove forests are important to the ecology of southern coasts -- they stabilize sediments, protect low-lying land from storm surges, and provide habitat for a diversity of fauna, particularly bird breeding rookeries (Humm 1973). Production of shrubby mangrove forests in northwest Florida averages 380g $dw \cdot m^{-2} \cdot yr^{-1}$, while mature mixed stands produce as much as 4600g $dw \cdot m^{-2} \cdot yr^{-1}$ (Odum et al. 1982). The latter figure is probably much higher than any CGUL stands would achieve, although a period of some years between freezes and/or hurricanes might raise the rate of production above the former figure for shrub mangroves,

Community structure of freshwater hardwood swamps in CGUL varies with extent of standing water. Sites with surface water throughout the growing season support cypress-gum swamps, with canopy dominated by Toxodium distichum, Nyssa biloba, and/or N. aquatica. Where soil is inundated for relatively short periods during the growing season, willows (Salix spp.), oaks (Quercus spp.), maple (Acer spp.), ash (Fraxinus spp.), and sweet gum (Liquidambar styraciflua) dominate the canopy, Communities in drier, peaty sites also include red bay (Tamals pubescens), sweet bay (Magnolia virginiana), and pines. Productivity of Gulf coast hardwood swamps has not been studied extensively, but this habitat is highly structured, receives subsidies of matter and energy from freshwater sources, and is expected to be highly productive. An average figure for freshwater hardwood swamps from a range of locations is 1600g $AFDW \cdot m^{-2} \cdot yr^{-1}$ (Teal 1980).

WESTERN GULF OF MEXICO

COASTAL HABITAT'S

The coastal region of the Western Gulf of Mexico OCS planning Area (the Texas Gulf coast) consists of two geologically distinct environments:

1. strandplain-Chenier plain system

The easternmost portion of the Planning Area, from the Texas-Louisiana border at Sabine Lake on the east to Galveston Bay on the west is characterized by narrow, high-energy sand beaches and extensive brackish and freshwater marshes among remnants of former beach ridges (cheniers).

2. Texas barrier islands region

The remainder of the Texas coast, from Galveston Bay west and south to the U.S.-Mexico border, consists of narrow barrier islands seaward of an extensive system of warm, shallow estuaries and lagoons.

Habitats and Productivity

Exposed beaches are ecologically uniform habitats facing the Gulf of Mexico along the entire Texas coast. Beaches in this area consist of fine, unstable, unconsolidated sand. Turbulence and transport effectively inhibit benthic primary production in this habitat (Shew et al. 1981 b), although quantitative data are lacking, Matter and energy subsidies from marsh macrophyte and/or water column phytoplankton production supper: several species of mollusks and crustaceans Heterotrophic bacteria are abundant in the sediments of Texas beaches (Fritts et al. 1981).

Cheniers and recent beach ridges inhibit salt water flux into marshes of the eastern Texas coast (Beccasio et al. 1982). Brackish water marshes occur where salinities average <10°/₀₀, and are dominated by halophyte grasses including Spartina patens and Distichlis spicot. Such marshes dominate sheltered wetland habitats in the Chenier Plain portion of WGUL (Gosselink 1979). In Chambers County in the Texas Chenier Plain, brackish water marshes produce 1300 -1900 $g \cdot m^{-2} \cdot yr^{-1}$ (Longley et al. 1981). Intermediate marshes of the Chenier Plain are periodically flooded with fresh water and occasionally key brackish water. Dominant plant species include S. patens, Saggittaria falcata, and Paspalum vaginatum (Gosselink 979). Primary production probably falls within the range reported by de la Cruz (1974), i.e., between 600-2330 $g\ dw \cdot m^{-2} \cdot yr^{-1}$.

Freshwater marshes are flooded only with water of salinity at or below 1 ppt and contain a great diversity of plants, Dominant species include Panicum hemitomon and Alternanthera philoxeroides but Typha, Sagittaria, Echinochloa, Zizania, and Eichornia are common; indeed, up to 93 species may be present (Longley et al. 1981.). In WGUL, freshwater marshes are extensive near the western side of Sabine Lake and occur throughout the Planning Area (Gosselink 197'3). Production of the entire community has no\ been evaluated, but favorable soil, moisture, and insolation (Longley et al. 1981) suggest very high rates of production. Sagittaria falcata, common in freshwater marshes of the Chenier Plain, produces 600-1500g dw·m^{-2}·yr de la Cruz 1974, Hopkinson et al. 1978).

Barrier islands of WGUL west of Galveston Bay support a unique and important flora. Beach and dune ridges facing the Gulf of Mexico are stabilized by grasses (sea oats, Uniola paniculata; Schizachyrium; Panicum, and Paspolum) and other hardy species, including morning glory (Ipomea spp.) and Texas prickly pear (Opuntia lindheimeri). Where dunes and shell ramps reach sufficient height (1.5 -2.0m above mean sea level) to inhibit salt spray and washover, mattes of saltcedar (Tamarix gallica), live oak (Quercus virginiana) and occasional mesquite (Prosopis spp.) occur. Barrier flats of mobile sands and shell wash form at the landward side of the islands and are vegetated with Androspogon, Sorghastrum, and Helianthus (Shew et al. 1981 b). Productivity of Texas barrier island communities has not been reported, but the harsh nature of the physical environment suggests low production rates.

Production, however, is not a reliable parameter for judging the ecological/economic value of barrier island plant communities. The role this vegetation plays in stabilizing sediments is critical to existence of the island chains which serve to buffer mainland shores from tides, storms, and currents; shelter highly productive lagoons and estuaries, and provide access to the sea for recreation and industry.

Extensive beds of submerged aquatic vegetation (SAV) occur in estuaries and lagoons landward of the barrier island complex. Distribution of SAV in this area is restricted primarily by turbidity and salinity. Species composition of SAV beds varies, but dominants include one or more of the following: Halodule beaudettei, Ruppia maritima, Thalassia testudinum, Cymodocea filiformis, and Halophila englemanni. Gross production of SAV beds in the Laguna Madre of south Texas exceeds 4000g·m^{-2}·yr^{-1}, and annual production of T. testudinum is 1000g C·m^{-2}. Near Matagorda, aquatic production (dominated by SAV) is approximately 1330 -1380g dw·m^{-2}·yr^{-1}. Productivity data for SAV on the remainder of the Texas coast are not available, but standing stocks range from less than 60g dw·m-2 "in turbid, low salinity waters to greater than 500g dw·m^{-2}. T. testudinum standing stock is reported to average 3000g dw·m^{-2} for the Texas coastline as a whole (Shew et al. 1981b). High productivity and the great areal extent of SAV beds in WGUL make them important as food and shelter resources for a variety of commercially valuable finfish and shellfish, as well as wintering waterfowl.

Benthic algal mats are found discontinuously on estuarine sediments of WGUL. Productivity of such mats has not been evaluated, but salt marsh algal mats in Georgia produce 200g C·m^{-2}·yr^{-1} (Pomeroy 1959). Drift algae often occur when benthic forms are detached from their substrate. Productivity of drifting Hypnea spp. (an abundant drift form) is 2.1g dw·m^{-2}·da^{-1}, but drifting algae often shade SAV beds, reducing production by the latter (Shew et al. 1981b).

WGUL Coastal Habitats

Large areas of salt marsh occur on both barrier island and landward sides of Texas Gulf of Mexico estuaries. Flora of Texas salt marshes is more diverse than elsewhere in the U.S. Dominant species include Spartina alterniflora, Batis maritima, Salicornia spp., Distichlis spicata, Spartina spartinae, and up to a dozen additional species. Irregular groves of black mangrove (Avicennia nitida) are found within the salt marsh zonation pattern (Shew et al. 1981b). Production of A. nitida in this area is probably somewhat higher than that reported for shrub mangroves of the Mississippi delta (380g $dw \cdot m^{-2} \cdot yr^{-1}$) but. less than the maximum (4600g $dw \cdot m^{-2} \cdot yr^{-1}$) for healthy mixed stands in Florida (Odum et al. 1982). Favorable relationships of temperature, light, and water movement allow salt marsh community production to be very high, ranging from 735 to 1846g $dw \cdot m^{-2} \cdot yr^{-1}$ (Turner and Gosselink 1975; Shew et al. 1981b). The role of salt marsh estuaries as nursery and development areas has been recognized by the Texas State Legislature, which has designated most tributary bays, bayous, inlets, lakes, and rivers on the coast as protected "nursery areas'" (Beccasio et al. 1982).

SOUTHERN CALIFORNIA

COASTAL HABITATS

The Southern California planning area encompasses five coastal counties: San Diego, Orange, Los Angeles, Ventura, and Santa Barbara; including all the California Channel Islands. Point Conception (in Santa Barbara County) represents a focus of differentiation between northern and southern biotas. The current planning area boundary thus subsumes two distinct. ecological zones with very different environmental patterns and processes. At the large spatial scale of the planning areas, however, inclusion of the relatively small area of the northern zone does not substantially alter conclusions regarding productivity and environmental sensitivity,

Four major habitat types are found in coastal southern California: uplands, sand beaches, rocky foreshore and offshore rocks, and wetlands. The channel islands differ from the mainland coast in distribution of habitat. types. On the islands, approximately 80% of the shore is rocky, while on the mainland, only about 16% of linear coast is rock foreshore (Littler 1978 a, b).

The four coastal habitat types are distinct in biotic structure and productivity. However, the open and "leaky" nature of coastal ecosystems and geophysical coupling by water flow (Clark 1977) assures biotic interdependence of these habitats,

Coastal uplands of southern California are patchwork of several communities, whose distribution is controlled by seasonal distribution of moisture and soil-available nutrients (Mooney & Parsons 1973). Coastal valleys are inhabited by grassland communities which are dominated by exotic species (including Avera Bromus and Festuca) and which are artifacts of human disbturbance (Hanes 197'7), Dry coastal slopes permit growth of coastal sage scrub communities dominated by Artemisia and including Baccharis, Eriogonum, Haplopappus, Opuntia, Rhus and Salvia (Hanes 1981).

True chaparral (evergreen shrub) vegetation is found in the southern California coastal environment, particularly in elevated areas and on the channel islands. The chaparral community is composed of several hundred vascular plant species, and is a favored watershed cover type (Hanes 1981).

Production ecology of southern California coastal uplands is poorly understood (Mooney & Parsons 1973). A stand of chaparral at 830 meters in Monroe Canyon (which is probably not atypical of coastal chaparral} fixed carbon throughout the year (Mooney & Parsons 1973) and produced approximately 1000 $kg \cdot ha^{-1}$ of above-ground vegetation per year (Sprecht 1969). Below ground productivity has not been estimated, but is probably a significant proportion of total production (Hellmens et al. 19.55).

Sand beaches comprise over 80% of linear mainland coastline and approximately 20% of linear coast on the channel islands (Littler 1978 a,b). Ocean beaches are harsh biotic environments, and require elaborate adaptations to variation in such factors as heat, salinity, desiccation, oxygen and particle size (Newell 1976). Despite the stresses imposed by this habitat, many species of invertebrates are adapted to life on open beaches. Anthozoans, cnidarians, polychaetous annelids, crustaceans, molluscs, ophiuroids, echinoids and holothurioids are all found on sand beaches of southern California (Hedgepeth 1968, Bright 1974). Population levels fluctuate with substrate characteristics and disturbance (Clark 1977) but the open nature of the habitat and rapid faunal transport are indicated by the ability of sand-beach organisms to recover community structure within two seasons following replenishment projects (Puller. and Naqvi 1983).

Due to water turbidity and substrate instability, in situ primary production of ocean front sand beaches is very low, and the entire ecosystem functions on subsidies of matter and energy scavenged from productive shoreward and offshore habitats (E. P. Odum 1983). Smith, Burns and Teal (1972) estimated the benthic metabolism of a low energy intertidal beach in Bermuda at 19-27 $mlO_2 \cdot m^{-2} \cdot hr^{-1}$ with oxygen consumption partitioned among bacteria (35%), microflora and fauna (60%) and macroflora and fauna (4.5%). Substrate features of this beach, including large pore space and oxygenated sediments render i? atypical for the Caribbean (Gray 1981), but these characteristics may make the production number of very approximate value fur California beaches. Due to greater wave action and lower temperatures on the west coast, benthic metabolism is undoubtedly lower on the California beaches than in Bermuda.

Rock habitats are found on both mainland and island shores. This is a dynamic and heterogeneous habitat type, with biotic community struture determined by impact disturbance upwelling, tides, exposure, substrate type, climate, competition for light, and grazing (Dawes 1981).

In two years of sampling on seven island and five mainland rocky intertidal sites, Littler (1980) recorded a total of 197 macrophyte taxa and 217 macro invertebrate taxa. Island sites were consistently richer in flora and fauna than mainland sites with the exception of invertebrate density, which is higher on the mainland (Table).

Dominant macrophyte species in the rocky intertidal of both islands and mainland include blue-green algae, the coralline algae Corallina (2 species), the red algae C&gtrrt.ins, the tracheophyte Phyllospadix and the phaeophyte Egregia menziesii (Littler 1980, Murray 1974). Total primary production of this assemblage was measured on the leeward side of San Clemente Island at approximately 485 net $gC \cdot m^{-2} \cdot yr^{-1}$. Littler and Murray 1974). Standing stock of macrophytes and macroinvertebrates was lowest at the low edge of the subtidal zone at twelve sites on the southern California mainland and channel islands (Littler 1980). An interesting feature of porous sandstone substrates in this region is a distinct zone dominated by lithothamnic algae, genus Lithophyllum (Stephenson and Stephenson 1972).

Subtidal rocky habitats support a continuation of intertidal zonation patterns in vegetation cover (Hodgson and Waaland 1979). In general, the shallow subtidal supports a diverse biotic community (Dawes 1981) whose temporal variability in structure is somewhat less than in the more variable physico-chemical regions of the intertidal (Littler 1980).

At depths of five to twenty meters adjacent to both mainland and island coasts are beds of lithophytic kelps dominated by the "giant kelp, " Macrocystis pyrifera. Macrocystis communities support a high diversity of associated organisms totalling over 810 taxa, including over 625 invertebrate species (MMS, 1984). The role of Macrocystis in maintaining the rich biota with which it is associated is dependent on both physical effects (substrate, shading) and energetics (available productivity). Physically, Macrocystis provides attachment substrate for sessile invertebrates, primarily on stipes and holdfasts, but also on fronds (Dawes 1981). Energetically, Macrocystis (indeed, brown algae in general) serve as food for urchins (Strongylocentrotus) which in turn support certain marine mammals (sea otters, <discussion below). Where urchin populations are increased by effects of sewage pollution, kelp forests may be decimated (Wilson et. al 1977) and when urchin populations are artificially suppressed, kelp coverage expands dramatically (Pearse and Hines 1979). It is important, however, to understand the role of spatial heterogeneity in maintenance of community diversity. Macrocystis is an aggressively dominant species, and when not grazed can outcompete other species for light and nutrients (Dawes 1981). Moderate levels of grazing by Strongylocentrotus urchins may play a role in determination of community structure attributes of Pacific kelp beds (Paine and Vadas 1969).

Productivity of Macrocystis in southern California is poorly studied. Biomass ranges from 3 to 22 kg/m^2 wet weight (North 1971). In Monterey Bay, Macrocystis produces approximately 23 kg wet, wght·m^{-2}·yr^{-1} (Jones and Stokes Associates, Inc. 1981), or about 6 kg dry weight. m^{-2}·yr^{-1} (using a 4:1 wet: dry weight ratio). In general, macro algal kelps are among the earth's most productive plants, and Teal (1980) provides a world average production of 3400 grams ash-free dry weight·m^{-2}·yr^{-1} for kelp communities.

Southern California marsh and mudflat systems are very poorly developed in comparison with east coast estuaries and even relative to more northerly sections of the Pacific coast. The southern California coast is geologically recent, no large river systems are present, and embayments are small. These factors combine to limit extent of salt. marsh estuaries, which depend on tidal flushing and sediments for their existence.

Vegetation diversity is low in marshes of southern California. Spartina foliosa dominates the community in saline areas, and structural heterogeneity is provided by Salicornia flats. Distichlis spicata is common, but is not a dominant species in most southern California marshes (Knutson and Wodehouse, 1982). Vegetational dominance shifts at Point Conception: north of the point, D spicata, Glaux maritima and Plantago maritima are important species, while south of the point Suaeda californica and Monanthochloe littorals are important marsh associates (Ho 197.1), California as a whole in 1977 bad only 36,000 ha" of marsh (Barbour and Mazin 1977), In southern California, only Morro Bay has extensive wetlands. Morrison Bay in San Diego County had 400 ha of marsh and mudflats, which has been reduced by human disturbance to 20 ha of marsh and virtually no mudflat (Knutson and Woodhouse 1982).

Productivity of southern California marshes has not been comprehensively studied. In Oregon, marsh production is comparable to that of east coast marshes, that is, about 5000 to 20,000 kg wet. wt $\cdot ha^{-1} \cdot yr^{-1}$ (Eilers 1979). In southern California, favorable conditions of light and temperature are probably overridden by stresses <Associated with salinity, lack of water flux and anthropogenic disturbance. Productivity of these marshes is probably low on an aerial basis. In the Tijuana estuary of southern California S. foliosa marsh community productivity was 0.4 to 1.0 kg dry weight shove-ground plant material net production $\cdot m^{-2} \cdot yr^{-1}$, but where fresh water impoundment lowered salinities, production rose to 1.2 - 2.9 kg dry wt $\cdot m^{-2} \cdot yr^{-1}$ (Zedler et al 1980).

Table 3 . Comparison of biota of rocky intertidal habitats in Southern California Planning Area. Data are from two sample years at seven island and five mainland sites. From Littler (1980).

Parameter	Mean Value Island	Mainland
Number of macro invertebrate taxa	74	70
Number of macrophyte taxa	77	76
Percent cover macro invertebrates)	97	95
Percent cover macrophytes)	18	14
Macro invertebr te density /m2	3054	3421
Organic dry weight (g/m^2) (macro invert.)	146	104
Organic dry weight (g/m^2) (macrophyte)	663	513
Diversity: Richness	20.02	17.01
Evenness	0,56	0,59
Shannon-Wiener	2.54	2.56

CENTRAL CALIFORNIA

COASTAL HABITATS

Habitats and Productivity

CCAL coastal habitats include wetlands, forests and rocks. Tidal coastline in this planning area is mainly rock, with pocket. beaches and relatively short stretches of open sand beach.

Coastal uplands in CCAL are very different from those in SCAL. CCAL forests are coniferous or mixed conifer/hardwoods. Production of this ecosystem is substantially higher than for the dry chaparral habitats of SCAL, and the forested uplands support a large number of important species of vertebrates.

Sand Beaches

Sand beaches comprise only 40% of CCAL coastline, and are distributed primarily in pockets among rocks and cliffs or in relatively short linear stretches (Woodward-Clyde 1982a, b). Many species of invertebrate in infauna and epifauna inhabit sand beaches, but population densities are generally low. Exceptions are short-term population "explosions" of motile burrowing bivalves and crustaceans which repond to local conditions and disturbance (Clark 1977).

In situ primary production of California beaches has not been measured. The highly disturbed nature of the substrate and turbidity of overlying water suggest that metabolism and production are both very low, the former probably much less than the 23 ml $O_2 \cdot m^{-2} \cdot hr^{-1}$ reported for a Bermuda sheltered beach (K.L. Smith *et al*. 1972).

Rocky foreshore and offshore rocks of CCAl support epilithic communities of diverse structure dependent on disturbance and exposure (Dawes 1981). In southern California, intertidal macroalgal communities nearly 500 net $gC \cdot m^{-2} \cdot yr^{-1}$ (Littler and Murray 1974) which figure probably approximates production in CCAL intertidal rock habitats.

Subtidal rock reefs support macroalgal kelp communities which are probably similar in productivity to SCAL beds. In CCAL, Monterey Bay *Macrocystis* produces about 23 kg wet weight $\cdot m^{-2} \cdot yr^{-1}$ (Jones and Stokes Associates, Inc. 1981a,b). At least 810 faunal taxa have been identified in kelp beds (MMS 1984c).

Coastal Wetlands

Pacific coast tidal marshes have not in the recent past been a dominant, coastal feature. Their sensitivity to disturbance has left them currently a minute total of Pacific coastal area (Lewis 1982, Zedler 1984). Marshes of CCAL have been most thoroughly studied in San Francisco Bay (Josselyn 1983). These marshes are inhabited by three endangered animals (the harvest mouse *Reithrodontomys raviventris*; black rail, *Laterallus jamaicensis coturniculus*; and clapper rail *Rallus longirostrus obsoletus*) and two endangered plants (Soft bird's beak, Cordylanths mollis minis and Jepson's pea, Lathyrus jepsonii). A variety of invertebrate species inhabit soft bottoms in or near CCAL wetlands. Densities of the bivalve Macoma balthico reach overage levels of over 1000 individuals" m^{-2} in suitable habitast (Vassallo 1969). At ieast 78 species of insects {and probably at least two or three times this number) inhabit. salt marsh vegetation (Josselyn 1983).

Above-ground primary production of CCAL marsh macrophytes ranges from 275 to over 1800 g dry weight·m^{-2}. Benthic microalgal cent.rihute between 0.8 and 1.4 times the macrophyte production to the community total (Zedler 1980). Below ground biomass is between 0.5 and 10 times that of above-ground standing stock (Good et al. 1982) and production necessary to support this biomass should be considered in the community total. In CCAL, belowground production estimates have not been reported.

N O R T H E R N   C A L I F O R N I A

COASTAL HABITATS

The coastline of NCAL consists of alternating stretches of rock face and sand beach. Intertidal rocks have distinctive patterns of zonation of lithophytic communities, with attached algae and Phyllospadix below mean low water, and crustacean and other arthropods, along with littorinid gastopods from near high water to the limits of the wetting zone. Productivity of interidal algae communities in NCAL should be less (on an annual basis) than the 485 net g C $\cdot m^{-2}$ yr^{-1} reported for similar habitats in SCAL (Littler and Murray 1974). High productivity, along with shelter and substrate structure provided by littoral and sublittoral rocks allow an abundant and diverse fauna to inhabit this otherwise harsh environment. Consumer organisms are particularly well represented in NCAL littoral rock habitats, with a surprisingly large number of taxa (74 species in 25 families) of true intertidal fish (Jones and Stokes 1981a, b). Productivity in CCAL kelp communities may be very high, up to 24,000 kg wet weight, $\cdot m^{-2} \cdot yr^{-1}$ (Winzler and Kelly 1977), Data are not available, but. it is likely that NCAL kelp beds produce at similar rates.

Sand beaches form long linear stretches between rock faces, or "pocket" beaches where boulders or cliffs shelter the shoreline. No macrophyte vegetation inhabits the shifting sand environment, and such microflora as there is is of low productivity due to substrate disturbance and turbidity, Thus, production of intertidal sands is low. The habitat is subsidized by carbon and nutrients from the water column and of terrigenous origin, and many species of motile infauna, including some shellfish harvested for sport and commerce inhabitat NCAL beaches (Hedgepeth 1968, Clark 1977).

Very little estuarine area is found north of San Francisco Bay. The only major estuary in NCAL is Humboldt Bay, which thus assumes increased importance because of the relative scarcity of such habitats. Several commercially valuable species of finfish and shellfish depend on Humboldt. Bay for "nursery" conditions (see Finfish and Shellfish discussion in this chapter).

Terrestrial habitats in NCAL maritime regions consist primarily of low productivity dune-and-swale systems and coastal scrub and forest,. Dunes in NCAL do not play the important role in coastal ecology that they play in Atlantic and Gulf areas. The shoreline of NCAL is steep and geomorphologically stable (but tectonically active). Biotic stabilization of coastal areas is not a factor in development. Above ground plant biomass is low, ranging from 26 to 348 grams wet weight per square meter (Barbour and Johnson 1977).

OREGON-WASHINGTON

COASTAL HABITATS

Much of the coastline of the ORWA OCS Planning Area is characterized by rugged, mountainous terrain, with heavily timbered slopes rising steeply from the shore. Small rocky islands that dot the coast are important habitats for colonial sea birds and marine mammals. From data reported by USFWS (1976), it can be calculated that the combined Oregon-Washington shoreline is over 5400km long, including about 46km in Puget Sound and Juan de Fuca Strait, Only 800km of the shore is Pacific Ocean coast. Approximately 19% of the total shoreline is sandy heath, .5-10% estuary-wetland frontage, and the remaining 71-76% is rocky (mostly bedrock, with some gravel and boulder beaches}. About 150 km of the Oregon shore is backed by sand dunes.

The Planning Area contains two of the nation's major estuaries: Puget Sound and the Columbia River estuary. Including several smaller bays and river-mouth estuaries along the Pacific coast, the total surface area of estuaries in ORWA is approximately 1000 km^2. Some of these tidewaters contain large beds of eelgrass (Zostera marina}, extensive areas of salt marsh and large tidal flats, and are important to waterfowl, shellfish and anadromous fish (USFWS 1976; 1981 [eco. inv. maps]).

Macrophytes and macroalgae

Although genera] distributional data are available (USFWS 1981), no information on marine vascular plant biomass or productivity have been found for the ORWA OCS Planning Area. Eelgrass and marsh grasses occur in most of the bays and estuaries in Oregon and Washington; these plants are extremely productive in other geographic] areas, and have been found to contribute important amounts of fixed carbon and other nutrient elements (such as nitrogen and phosphorus) to coastal waters (e.g. Barsdate et al 1974).

Macroalgae (kelps, rockweeds, sea lettuce, and others) are important sources of primary production in the ORWA coastal zone. The abundance of rocky shore provides extensive habitat for kelps and various intertidal macroalgae, Krauss (1977) calculated that under ideal upwelling conditions, and with cultivation, the Oregon coast could supply 1.17 x 10^6 metric tons of marine algae per day, or a total crop of 52.5 x 10^6 tons in a single upwelling season. In situ measurements of subtidal macroalgal productivity are difficult and rare, but kelps cultured in natural seawater in the Puget Sound region produced between 93.5 and 2154g dry weight m^{-2} yr^{-1} - and reached an optimum biomass of up to 4800g fresh weight m^{-2} (Waaland 1977). Assuming that kelp plants are 40% carbon by weight, the productivity values represent 374-862 gC m^{-2} yr^{-1} which are 5-12 times values for offshore phytoplankton production and 1.2-2.9 times those for coastal phytoplankton production given by Banse (1.973] for Oregon and Washington waters.

Five species of intertidal macroalgae in Northern California gave net CO_2 uptake rates in air and water ranging from 1.4-11.2mg CO_2 dm^{-2} hr^{-1} (Johnson et al 1974); in more standard units these rates are equivalent to 38.2-305mg C

m^{-2} hr^{-1}. In the high intertidal of Oregon, various algae are abundant and apparently productive during the winter, but disappear in summer under the combined pressures of dessication and herbivory by limpets (Cubit 1984). However, surfgrass (Phyllospadix souleri), a vascular plant, is a persistent and dominant species in the Oregon rocky intertidal throughout the year, covering from 14-80% of the substrate at two study sites. Recovery of surf grass from disturbance (physical removal) is extremely slow (Turner 1985). Williams and McRoy (1982) measured light-saturated carbon uptake by P. scouleri in Alaska at 1.08g C gdw hr^{-1}, a relatively high productivity.

D'Antonio (1985) investigated epiphytic (microalgal) growth on the intertidal red macroalga Rhodomela larix on the Oregon coast. Ephiphyte to host plant dry weight ratios ranged from 0.27-29.8, demonstrating that epiphytes can increase significantly the biomass of primary producers in the intertidal environment. As heavy epiphytic growth can depress photosynthetic rates of host plants, the effect on net productivity of the epiphyte:host complex may not be linear with increasing biomass.

The rocky intertidal zone in the Pacific Northwest supports dense beds of mussels (Mytilus californianus and M. edulis), which are characterized by a very rich assemblage of at least 300 species of animals and plants (Paine 1984).

GULF OF ALASKA

COASTAL HABITATS AND COMMUNITIES

The coastal morphology and biotic habitats of the Gulf of Alaska OCS Planning Area are extremely diverse. The southernmost coast of Alaska, from the US-Canadian border to Cross Sound, is an extensive complex of islands, inlets, bays, and fjords. Although this area is but a small portion of the Alaska Geographic Region, it contains a large proportion of Alaska's total shoreline. Dense kelp (Laminaria spp.) forests are present in the intracoastal waters, extending from the low intertidal zone to 20m depth (Calvin and Ellis 1981).

Primary production by kelp and other macroalgae is quite high even at far northern latitudes, as the dominant species are well-adapted to growth at low temperature and light intensity, Mann (1972) estimated the annual production of kelp beds (in Nova Scotia) at 648,000 $gC \cdot m^{-1}$ of shoreline, equivalent. to 1750 $gC \cdot m^{-2}$ of open water. Kelp favors areas of strong currents (Calvin and Ellis 1981) and much of its production is probably transported to offshore waters as dissolved and particulate organic matter (Mann 1972). Kelp beds therefore provide important resources for pelagic and benthic secondary production.

F'reject OCSMAPS researchers were unable to identify studies of the distribution and ecological associations of macro algal populations for most of southeastern Alaska. However. areas where these populations are present must be considered highly productive in .terms of carbon fixation, export Of organic matter to offshore waters, and habitat for fish and invertebrates.

The Alaskan coastline north and west of Cross Sound is less complex, consisting of relatively linear sand and gravel beaches, interrupted by occasional bays, fjords, and river mouths, notably Yakutat Bay, Icy Bay, the Copper and Bering River deltas, and Orca Inlet..

From Dry Bay northwest to Yakutat Bay, in the Copper and Bering River deltas, and in Orca Inlet, there are large areas of wetlands, including back bays, marshes, mudflats, and sand flats (ADFG 1984a). Although specific productivity data are not available for these wetlands, they must be considered very productive based on the numerous bird colonies and marine mammal concentrations reported (Sowls et al. 1978; Arneson 1980; ADFG 1984a; MMS 1984a). Biological cover on beaches, as recorded from aerial surveys, is light or moderate to absent along this section of coast (Sears and Zimmerman 1977). This is to be expected, as sand and gravel do not generally support. stable epifaunal communities in the intertidal zone. However, the extensive areas of mud flats in the river deltas are likely to support large numbers of infaunal organisms, as indicated by the numerous clam beds in the Copper River delta (ADFG 1984a).

The coast of the westernmost part of GOAK, from Hinchinbrook Island to the western portion of Prince William Sound, is generally steep and rocky. Much of the shore is bedrock with limited areas of sand, gravel, and boulder beaches (Sears and Zimmerman 19'77). This area is habitat for large concentrations of sea otters, sea lions, waterfowl, and shorebirds (ADFG 1984a). Sears and Zimmerman (1977) documented moderate to heavy biological cover for most of the shores of Hinchinbrook and Montague Islands. Presumably, this biological cover is mainly composed of the macro algae and sessile invertebrate communities typical of the northern rocky intertidal zones.

Wet. weight. biomass of dominant macroalgal species and numerical abundance of dominant macroinvertebrate species were reported from several rocky littoral sites in the northeastern Gulf of Alaska by Lippincott (1980). Macroalgal biomass ranged from 3.8 to over 14,000 $g \cdot m^{-2}$, with a mean of 2927 $g \cdot m^{-2}$. Macroinvertebrate densities were quite high, averaging 35,577 individuals per m^2, with a maximum of 104,000 per m^2. Mussels (Mytilus edulis) and barnacles (Balanus glanchula) were the most numerous organisms overall, and either or both were most abundant at the majority of sites.

A

KODIAK

COASTAL HABITATS AND COMMUNITIES

Coastal environments of the Kodiak OCS Planning Area are separated into two geographically distinct, but ecologically similar, regions:

1. offshore islands -- including the Barren Islands, the Kodiak Archipelago, Chirikof Island, and the Semidi Islands;

2. mainland coast -- the coast and nearshore islands of the Alaska Peninsula, from Cape Douglas to 157°W.

A third region, of exceptional importance as a feeding ground for marine birds and mammals, is the extensive area of shallow water banks (Portlock and Albatross Banks) east and south of the Kodiak Archipelago. In this area, frequent mixing of bottom and surface waters provide a nutrient-rich environment and an abundance of food for both plants and animals (ADFG 1982a).

The exposed shores of KODK are rocky and in many places steep or vertical (Sears and Zimmerman 1977). However, numerous estuaries, bays, and fjords provide habitat diversity in the form of protected waters and sand or gravel beaches. Approximately 60% of both the mainland and island shores of KODK possess bedrock or boulder substrates with moderate to heavy biological cover (Sears and Zimmerman 1977; Arneson 1980). Biological cover on sand and gravel beaches is light or absent.

Intertidal and shallow subtidal zones (to about 20m depth) of KODK are dominated by macroalgae, with rockweed (*Eucus distichus*) in the higher intertidal, and kelps (*Alaria Agarum, Pleurophycus*, and *Laminaria* spp.) in the lower intertidal and subtidal zones (SAI 1980a). Kelp beds extend 400m-10km from shore. Biomass estimates range from 4.8-18.3kg·m^{-2} (fresh wt.), and total standing stock in the Kodiak area has been estimated at 2.3x10^{9} kg. Rockweed biomass is estimated at 9x10^{7}kg (Zimmerman *et al.* 1979).

Mann (1 972) has estimated annual net production by northern temperate kelp beds at 1750g C·m^{-2}·yr^{-1}, equivalent to 648kg C·m^{-1} of linear shoreline. Kelps turn over their biomass from 3-20 times per year, with the losses entering marine food webs through direct grazing, detrital export, and release of dissolved organic matter (Mann 1972).

Flat bedrock beaches in KODK support extensive beds of surfgrass (*Phyllospadix* sp.). Williams and McRoy (3.982) determined that mean light-saturated C uptake by *P. scouleri* in Alaska was 1.08g C·gdw^{-1}·hr^{-1}, a relatively high productivity. Unfortunately, biomass and distributional data required for areal production estimates for this genus apparently are not. available.

Small beds of eelgrass (*Zostera marina*) occur in muddy areas of protected bays and lagoons in KODK (Zimmerman *et* al. 1979). Eelgrass is an extremely productive species in other areas of the Alaska Geographic Region (McRoy 1974), but the small amount of suitable habitat suggests that its contribution to KODK productivity is local and relatively unimportant overall.

SAI (1980a) reported that intertidal and shallow subtidal zones of the Kodiak Island area were "highly productive. " Based on a similar distribution of rocky shores, kelp beds, and bird and mammal concentrations (Sears and Zimmerman 1977; ADFG 1984a), this description should apply to the Alaska Peninsula ("...an area of superb and pristine beauty...."; BLM 1981a) and nearshore islands as well.

Tile KODK OCS Planning Area contains many large colonies, concentrations, and overwintering areas of seabirds, numerous sea lion and harbor seal pupping areas, and haul-outs. The region is of major importance to Alaskan sea otter populations (Scheffer 1972; Sowls et al. 1978; Gusey 1979a; Arneson 1980; ADFG 1984a). The Portlock and Albatross Banks are situated on the primary migration route of gray whales and northern fur seals and probably are seasonal feeding grounds for several species of whales [BLM 1981a (Graphic 12); MMS 1984a (Graphic 3)]. Kodiak Island and the Alaska Peninsula are also important areas for terrestrial mammals, especially the brown bear (Ursinus sp.). This brown bear population is unique, and an important economic as well as biological resource (BLM 1975 b).

COOK INLET

COASTAL HABITATS

The coastal environments of the Cook Inlet OCS Planning Area may be divided into two very different habitats: Cook Inlet proper, and the southern Kenai Peninsula, including Blying Sound and westernmost Prince William Sound.

Southern Kenai Peninsula

The shores of the southern Kenai Peninsula are mostly steep and rocky with many islands, bays, and fiords. Biological cover in the intertidal zone is generally heavy (Sears and Zimmerman 1979). Kelp beds and macroalgae dominate the low intertidal and higher subtidal zones along exposed shores, and eelgrass (Zostera marina) beds are well-developed in the more protected waters of the bays and fjords (Lees and Rosenthal 197'7). ADFG (1984a) maps show 23 Steller sea lion rookeries and numerous harbor seal concentrations in the area. Sea otters are present along the outer Kenai Peninsula coast (Gusey 1979a; ADFG 1984a). There are more than 86 seabird colonies in this portion of CKIN (Sowls et al. 1978).

Eelgrass beds in Koyuktulik Bay cover $1.14x10^6 m^2$, with biomass estimated at 25-406 $g \cdot m^{-2}$, and cover $3x10^5 m^2$ in the w. arm of Fort Dick, with biomass of 23-151 $g \cdot m^{-2}$ dry wt. (Lees and Rosenthal 1977) (MAP #105). Primary production by these grass beds can equal or exceed phytoplankton production on an areal basis (Harding and Butler 1979). McRoy (1974) estimated net production by eelgrass at 1000-1500 $g\ C \cdot m^{-2} \cdot yr^{-1}$ in Izembek Lagoon, Alaska. Kelp and other macroalgae are also very productive (>1750 $g\ C \cdot m^{-2} \cdot yr^{-1}$; Mann 1972). Much of this aquatic vegetation and macrophyte production is transported as detritus and dissolved organic matter to distant. and offshore areas, where it forms an important base for benthic and pelagic food chains (Mann 1972; Lees and Rosenthal 1977). The latter authors described the nearshore environments of Chugach Bay and E. Chugach Island (MAP #105) as ".., robust, pristine, and ,.. highly productive. "

Cook Inlet

The shores of Cook Inlet proper slope gently, with substrates that range from bedrock in the southwest to fine sand and mud farther north and east. Biological cover in the intertidal zone is mostly absent (Sears and Zimmerman 1979) due to the general lack of hard substrate and, possibly, to the extreme tidal range of 3.7-5.5m (BLM 1981a).

Macrophytes, especially kelp and eelgrass, dominate the lower intertidal and sllbi.ids] zones from the tip of the Kenai Peninsula throughout Kachemak Bay, along the east coast of Cook Inlet to ahout 60°N, and along the west shore of the Inlet from north of Kamishak Bay to the Planning Area boundary at 59°N (MAPS #101, 105, 106). Brown algae biomass in Kachemak Bay is estimated at 230 $g \cdot m^{-2}$ in winter to 5600 $g \cdot m^{-2}$ in midsummer (SAI 1979). The central and upper reaches of Cook Inlet are surrounded by large areas of intertidal mud and sand flats with marshes and wetlands that extend far inshore.

Sandy substrates in the lower intertidal support a large population of redneck and razor clams, while muddy substrates have large numbers of soft-shelled clams and other invertebrates (ADFG 1979b; AGAACL 19.81). The wetlands of Cook Inlet are staging areas for many species of shorebirds and waterfowl. Ducks, geese, and swans nest in these wetlands; moose and caribou calve and winter here, and brown bears feed in the productive marshy meadows.

Published map sets displaying the distributions of coastal birds, mammals, and aquatic plants in CKIN include ADFG (1979b, 1984a); BLM (1981a); and MMS (1984). Seabird colonies are mapped in detail in Sowls et al. (1978).

SHUMAGIN

COASTAL HABITATS

Coastal habitats in the Shumagin OCS Planning Area include the southern Alaska Peninsula from 157°W to its western end, the southern coast of the Aleutian Islands from Unimak to Akutan (166°W), and numerous smaller islands and reefs, including the Shumagin and Sanak groups. Most of the coast is steep and rocky, but there are numerous bays and fiords which provide protected shallow-water habitats and limited areas of wetland.

Estimates drawn from aerial survey maps (Sears and Zimmerman 1977) indicate that approximately 65% of the linear shoreline is rocky (bedrock or boulder), 35% sandy (sand or gravel), and <1% is wetland (shown as mud beach on survey maps). 'I'he total area of wetlands in the Planning Area, estimated from topographic maps, is 5600ha.

Coastal environments within SHUM apparently are the least known and least studied in Alaska. The only quantitative macrophyte data from the region appear to be those of McRoy (1970), who estimated the eelgrass (Zostera marina) stock in Kinzarof Lagoon at the head of Cold Bay on the south Alaska Peninsula. The area occupied by eelgrass was 871ha, with a total crop of 153,000 metric tons. The standing stock was 1840g dry $wt \cdot m^{-2}$, the highest of ten stations studied in Alaska, and among the highest in the world. Eelgrass occurs in other lagoons and coastal areas in SHUM (Mc Roy et. al. 1971; Sears and Zimmerman 1977), but no quantitative data are available.

Although data are extremely limited, macroalgae (kelp, rockweed, and other varieties) must be inferred to be important primary producers in the rocky intertidal and shallow subtidal zones of SHUM. Kelp beds are nearly ubiquitous features of coastal survey maps (Sears and Zimmerman 1977), and rockweed (especially Fucus distichus) dominates the rocky intertidal zone throughout much of the Alaskan coast (Zimmerman et al. 1979; Lippincott 1980; McBride et al. 1982). Curiously, a summary of coastal habitats hy the University of Alaska (1976) described the occurrence of large kelp beds as "infrequent" along the southern Alaska Peninsula; as this report predated formal surveys (Sears and Zimmerman 1.977), the discrepancy probably is attributable to a lack of information.

Both kelps and eelgrass are extremely productive under appropriate conditions. Annual primary production of kelp beds in northern waters was estimated at 1750g $C \cdot m^{-2}$ (Mann 1972). Eelgrass production in Izembek Lagoon (quite near Kinzarof Lagoon; see SGBA and NABA coastal summaries) is 1-8g $C \cdot m^{-2} \cdot da^{-1}$ during the active growing season (Barsdate et al. 1974). With a somewhat higher standing stock of eelgrass than Izembek Lagoon (McRoy 1970), Kinzarof Lagoon eelgrass should equal or exceed this very high productivity.

Although the quantity of eelgrass in SHUM probably is limited by the relatively small amount of suitable habitat, there appears to be a very large amount of habitat suitable for kelp and other macro algae. Kelps in Gulf of Alaska waters extend from the lower intertidal to 20m depth, and in some areas as much as 10km from shore {Calvin and Ellis 1980); Zimmerman et al. 1979) so the biomass of macroalgae in SHUM may be presumed to be quite large.

Kelp and eelgrass release a large portion of their production into coastal waters as both dissolved and particulate organic matter, and may contribute significantly to carbon, nitrogen and phosphorus budgets of nearby coastal and shelf waters (Mann 1972; Barsdate et al 1974). Apparent centers of abundance of sea otters, sea lions, harbor seals, and several species of seabirds in SHUM may be closely associated with these important sources of primary production.

NORTH ALEUTIAN BASIN

COASTAL HABITATS and COMMUNITIES

The North Aleutian Basin OCS Planning Area is bounded on the east and southeast by the Alaska Peninsula, on the north and northeast. by the Alaskan mainland coast, and on the west by the Bering Sea.

Open water areas in NABA lie entirely over the broad, shallow (<100m deep) shelf areas of Bristol and Kuskokwirn Bays. The major portion of the coastline, from Izembek Lagoon to Kulukak Bay, is primarily low-lying, with long stretches of sand beach broken by several large bays and lagoons. From Kulukak Bay to Cape Newenham, the coast is more rocky, with bedrock, gravel, and boulder beaches. Headlands and exposed shores of Cape Peirce, Cape Newenham, Hagemeister Island, and the Walrus Islands are rocky, and steep or vertical (Sears and Zimmerman 1977). There are large areas of intertidal mud and sand flats in protected bays and lagoons throughout. NABA.

Aerial survey maps of the NABA shoreline (Sears and Zimmerman 1977) show light to absent biological cover on sandy beaches, and moderate to absent cover on gravel and rock substrates, Ground surveys of 75km of intertidal beach near Togiak (MAP #120) showed moderate macrophyte cover of most areas, dominated by rockweed (*Fucus* sp.), with smaller amounts of kelp (*Laminaria* sp.), eelgrass (*Zostera marina*), and other species. Estimated biomass of *Fucus* sp. over the 600ha of beach sampled was 1.7×10^6kg wet weight, an average of $280 g \cdot m^{-2}$ (,McBride *et al*. 1982).

Izembek Lagoon (IMAP #118), the major portion of which lies within NABA, contains some of the largest, densest, and most productive eelgrass beds in the world. Eelgrass primary production in Izembek Lagoon averages $4.8 g\ C \cdot m^{-2} \cdot da^{-1}$ during the growing season, equivalent to $1000\text{-}1500 g\ C \cdot m^{-2} \cdot yr^{1}$ (McRoy 1.974), or approximately $1.7\text{-}1.8 \times 10^6 kg\ C \cdot yr^{-1}$ for the entire lagoon (Barsdate *et al*. 1974). Only a small percentage of the eelgrass production is consumed or decomposed within the lagoon; large amounts of organic carbon, as well as substantial amounts of nitrogen and phosphorus, arc exported to the Bering Sea shelf. These exports may contribute significantly to nutrient budgets and food chains on the southeastern Bering Sea shelf (Barsdate *et al*. 1974).

The lagoons of the northern Alaska Peninsula arc areas of major importance to migratory waterfowl, shorebirds, whales, and harbor seals, while rock cliffs and offshore waters of Bristol Bay support millions of sea birds. Pack ice, which extends well into Bristol Bay during late winter and spring in most years, is an important habitat for several species of marine mammals.

Rivers and coastal waters of Bristol Bay support one of the world's largest salmon populations. There is also a very large biomass of shellfish, especially surf clams (*Spisula polynyma*), in Bristo l Bay (Gusey 1979b).

ST. GEORGE BASIN

COASTAL HABITATS

The coastal environments of the SGBA OCS Planning Area include a small portion of the western Alaska Peninsula, the Aleutian Islands from Unimak Island to Amukta Pass, the Pribilof Islands, and Amak Island. Shores are generally rocky and often steep, although there are long stretches of sandy beach on Unimak and Umnak Islands, and intertidal mudflats in bays and lagoons throughout the area. Biological cover is moderate to heavy on the rocky shores and light to absent on sand and mud substrates (Sears and Zimmerman 1977).

Detailed survey data apparently are not available for most of the region, but the upper intertidal zone on rocky shores probably is dominated by rockweed (*Fucus* sp.) as on Kodiak Island (Zimmerman et al. 1979) and the beaches of Bristol Bay (McBride et al. 1982). Sears and Zimmerman (1977) observed many kelp beds in their aerial surveys of the Aleutian Islands, and Calvin (1981) reported dense forests of kelp and other macro-algae in the Pribilofs. Kelp beds in Alaska occur at depths from the lower intertidal to 20m (Calvin and Ellis 1981); the large areas of shallow, rocky shelf in the Aleutian Islands should support an enormous biomass of macro algae.

Izembek Lagoon, the western portion of which is included in SGBA, contains the largest eelgrass (*Zostera marina*) beds in the world (Barsdate et al. 1974). Extensive eelgrass beds also occur in Bechevin Bay (Sears and Zimmerman 1977).

Both kelps and eelgrass are extremely productive under appropriate conditions. Annual primary production of boreal kelp beds has been estimated at 1750g $C \cdot m^{-2}$ (Mann 1972). Barsdate et al. (1974) estimated the total eelgrass production in Izembek Lagoon at 1.8×10^6 kg $C \cdot yr^{-1}$; this estimate was based on a production rate of 1.8g $C \cdot m^{-2} \cdot da^{-1}$ during the active growing season. Kelp and eelgrass release a large portion of their production into coastal waters as both dissolved and particulate organic matter, so Izembek Lagoon is thought to contribute significantly to the carbon, nitrogen and phosphorus budgets of the southeastern Bering Sea (Mann 1972; Barsdate et al. 1974). These important sources of primary production may be closely associated with the extraordinary concentrations of seabirds, waterfowl, marine mammals, shellfish, and anadromous fish in the southern Bering Sea and Aleutian Islands.

NAVARIN BASIN

COASTAL HABITATS

No land exists within the formal boundaries of the Navarin Basin OCS Planning Area. St. Matthew Island, a part of the Bering Sea National Wildlife Refuge and a National Wilderness Area, about 110km to the east, is the nearest point of land.

Three oceanographic domains are recognized within NAVB: mid-shelf, shelf break, and oceanic. These domains were defined on the basis of benthic contours by Pelto and Peterson (1984a), with the mid-shelf (<100m depth) domain occupying the northeastern 10% of the Planning Area, the shelf break the central 50%, and the oceanic the southwestern 40% of the Basin, The conflicting definition of these domains in Springer and Strauch (1984; see their Figure 7.2) appears to be unnecessarily arbitrary.

Despite the lack of coastal habitats, seasonal pack ice, particularly the marginal ice zone (MIZ) at the seaward front of the pack, is important habitat for marine birds and mammals. Pack ice generally reaches the northern part of NAVB in December, with maximum extent along the shelf break by March or early April. The Basin usually is clear of ice by mid-June. The MIZ is characterized by floes which increase in size and proximity over a band approximately 110-115km wide (Pelto and Peterson 1984 b).

ST MATTHEW HALL

COASTAL HABITATS and COMMUNITIES

The SMHL OCS Planning Area includes the Alaskan mainland coast from the north shore of Kuskokwim Bay to the northern Yukon River Delta, Nunivak Island, and the offshore islands of the St. Matthew-Hall group. Nearly all of the marine waters of the Planning Area overlie the shallow (<100m) Bering Sea shelf.

The main land coast exhibits relatively little relief and is gently sloping for the most part, with extensive areas of intertidal mud flats. Much of this coastline is a part of the vast Yukon-Kuskokwim Delta. Here the littoral zone is many kilometers wide; storm surges during late summer and early fall may drive Bering Sea water up to 40km inland, inundating thousands of hectares of wetland tundra. Large areas of shallow coastal water support "'lush" stands of sedges and pondweeds, and much of the intertidal zone is heavily vegetated (Sears and Zimmerman 1977; Zimmerman 1982; ADFG 1984a). Unfortunately, information on intertidal and littoral plant communities in this region appears to be entirely descriptive or anecdotal. Little quantitative distributional, biomass, or wetland productivity data have been identified. King and Dau (1981) reported that the Yukon Delta area contained 311,191ha of "unvegetated" intertidal wetlands. including an unknown area of eelgrass (Zostera marina) beds, and 925,2 82ha of vegetated inter tidal wetlands, the latter covered by sedges (Carex spp.) and other grasses.

Rocky shores in SMHL occur at Cape Romanzof on the mainland, and on Nunivak, Nelson, St. Matthew, Hall, and Pinnacle Islands. These areas undoubtedly support kelps, rockweed, and other macroalgae, as elsewhere in Alaska, but even descriptive information appears to be lacking. Photosynthesis and respiration measurements were made on three species of macroalgae (Halosaccion sp., Fucus sp. and Laminaria sp.) collected from Nunivak Island during March and April, 1968 (Healey 1972). Net photosynthesis and growth were possible under 70cm of clear ice, at temperatures of 0° C or less.

Bering Sea pack ice and land-fast ice, typically present. in SMHL from December to late April, are critical habitats for several species of marine mammals, including bowhead whales (endangered and rare), beluga whales, walrus, and four species of seals. Pack ice of the northern Bering Sea provides habitat for approximately one million marine mammals. Benthic feeding marine mammals (bearded seals, walrus, and gray whales) may have highly significant effects on the productivity of the northern Bering Sea shelf. Their feeding activity resuspends large amounts of sediment, releasing buried plant nutrients (esp. nitrogen and phosphorus) into the water column. These nutrients may then be available to enhance primary product ion by phytoplankton (Fay 1981; Johnson and Nelson 1984).

Coastal areas of the Yukon-Kuskokwim Delta are critical nesting, molting, feeding, and staging areas for millions of waterfowl and shorebirds.

NORTON BASIN

COASTAL HABITATS

The Norton Basin OCS Planning Area contains a diversity of coastal habitats, ranging from protected lagoons and intertidal wetlands to exposed rocky sea cliffs. The shores of the Yukon Delta and Pastel Bay are fringed with intertidal mudflats, but the rest of the mainland coast is characterized by alternating bedrock, boulder, gravel, and sand beaches. St. Lawrence Island has long stretches of sand and gravel beach interspersed with rocky capes and headlands (Sears and Zimmerman 1977; ADFG 1981e: Graphic 2).

The Planning Area contains sixteen lagoons, not including those on St. Lawrence Island, with a total area of 88,105ha. Most or all of these contain eelgrass (Zostera marina) beds. Rocky shores throughout the region support kelp beds; pondweed (Potamogeton sp.) grows in shallow, clear water areas at the edge of the Yukon Delta (Zimmerman 1982; King and Dau 1981; ADFG 1981e: Graphic 2). Kelp and eelgrass both are highly productive under appropriate conditions (Mann 1972; McRoy 1974), but, apparently, no macrophyte productivity studies have been under taken in northern Alaska. McRoy (1970) measured eelgrass standing stocks in two lagoons on the Seward Peninsula; Safety Lagoon contained 47,000 metric tons and Port Clarence contained 5000 metric tons. Both measurements were based on fresh weight, believed to represent approximately nine times the dry weight.

Intertidal wetlands in NORB, excluding the Yukon Delta, total 71,774ha. About 60% of these support wetland tundra vegetation, mostly sedges (Carex sp.), while the other 40% either is unvegetated or contains eelgrass (King and Dau 1981). Roughly 200,000ha of the Yukon Delta are contained in NORB; virtually all of this area is intertidal wetland (ADFG 1981e: Graphic 2). Wetland and lagoon areas in the Planning Area are important. habitats for waterfowl anti shorebirds.

From November to May in typical years, all of the marine waters in NORB are covered by pack ice, an extremely important habitat for several species of marine mammals and birds. Large numbers of marine mammals (perhaps more than two million) use NORB habitats for migration, feeding, wintering, or reproduction (ADFG 1981e).

HOPE BASIN

COASTAL HABITATS

The Hope Basin OCS Planning Area encompasses the southeastern Chukchi Sea from the Bering Strait to 69° N, just north of Cape Lisburne. Coastal habitats in HBAS are diverse, ranging from salt marshes and protected lagoons to rocky offshore islands and sea cliffs, but detailed survey information has not been uncovered in this study. The following descriptions are drawn mostly from the summary of coastal bird habitats in Drury et al. (1981) and from topographic maps (ADFG 1984a).

Rocky shores in HBAS occur in the vicinities of Capes Lisburne and Thompson, along the southern shore of Kotzebue Sound, and on islands [Little Diomede and Fairway Rocks; Puffin and Chamisso]. These areas account for roughly 20% of linear shoreline, South and east of Cape Espenburg the shore is lined by small sand islands, and there are large sand dunes to the west of the Cape. The remainder of the coast consists mainly of sand and gravel barrier islands backed by numerous "highly productive" lagoons (Drury et al. 1981.) and large areas of wetland. Available information supports only crude estimation of the linear extent of intertidal wetland in HBAS. If only river deltas and lagoon inlets are considered, less than 10% of shoreline is "wetland," but if lagoons and areas shown as "wet land" on topographic maps are included, this figure appears to be at least 50-70%.

Coastal lagoons in HBAS were described as having "prolific" plant growth by Drury et al. (1981). Mason (1980) studied plant communities in small salt marsh lakes on the Baldwin Peninsula (MAP ≥150) where the dominant plants were sedges (Carex spp.) and salt-tolerant grasses (Puccinellia and Stellaria); these were grazed by geese and caribou. No other data on macrophyte or macro algal distribution, abundance or productivity have been found for HBAS. Lagoons on the south side of the Seward Peninsula (see NORB OCS Planning Area) support eelgrass (Zostera marina: McRoy 1970), and this very productive species may occur in HBAS lagoons as well. Rocky shores throughout Alaska support kelps and other macroalgae, so these important sources of primary production should be presumed to occur wherever there is suitable habitat. The large areas of salt marsh and coastal wetland in the Planning Area are important to waterfowl (Drury et al. 1981), and probably are quite productive during the short Arctic growing season.

Sea ice, shorefast ice, and near shore leads in HBAS are important. habitats for marine mammals, especially during spring migrations (Burns et al. 1981a).

CHUKCHI SEA

COASTAL HABITATS

Most references to the northern Chukchi Sea and the former Barrow Arch OCS Planning Area have treated the Alaska coast from Point Hope to Point Barrow as a unit. However, present boundaries of the CHKS OCS Planning Area exclude the coast northeast of Wainwright (see BEAU) and southwest of Cape Beaufort (see HBAS). The following discussion necessarily contains some overlap between these Planning Areas, especially with respect to migrant birds and marine mammals,

The northern Chukchi Sea is characterized by a mostly flat, shallow shelf, less than 20m deep in nearshore areas and less than 60m deep over most of its offshore extent. Tides are generally less than 15cm, but late summer and autumn storm surges may raise local sea levels by 2.7-3m. These surges probably do not cause extensive coastal flooding as in some other areas of Alaska, because much of the shoreline is backed by tundra cliffs 3-14m high (Lewbel and Gallaway 1984).

Marine waters in CHKS are 98-99% covered by sea ice from January to May, and 40% covered from August to October. The open water season commences with freshwater flooding and ice break-up in June. Pack ice and shore-fast ice are important habitats for marine mammals throughout the Planning Area, and throughout much of the year (Hums et al. 1981a). A flaw-lead zone between the shorefast ice and pack ice, extending along most of the coast at about the 20m isobath, persists through the winter and spring. This is an exceptionally important habitat for mammals and birds, especially during spring migrations (Schamel 1978; Roseneau and Herter 1984; Truett 1984 b).

Much of the coast of CHKS is fronted by harrier islands, which also enclose Kasegaluk Lagoon, a critical area for waterfowl. Kasegaluk Lagoon contains large areas of intertidal mudflat and salt marsh, but quantitative data on the areal extent and productivity of these wetlands are lacking, Saltgrass (Puccinellia spp.) and sedges (Carex spp.) are dominant, vascular marsh plants near Icy Cape (Roseneau and Herter 1984).

Gravel and boulder patches in nearshore waters support kelps and other macroalgae, probably to a greater extent than in the Beaufort Sea, but these plants are less important than phytoplankton as sources of primary production in CHKS (Truett 1984b). No data on macroalgal biomass or productivity have been found for the Planning Area.

The inner shore of Kasegaluk Lagoon is lined by gravel beaches 10-100m wide (Lewbel and Galloway 1984), and judging from the sedimentological map in Lewbel (1984), gravel beaches should predominate throughout the Planning Area except irr the vicinity of river deltas and mudflats. Very crude estimates for linear extent of beach substrates are: 90% gravel, 10% wetland (mudflat, marsh, and delta), and less than 1’% sand.

CHKS Coastal Habitats

ADFG (1981a, 1981b, 1984a) has prepared map sets depicting coastal habitats and bird and mammal distributions in the CHKS OCS Planning Area.

BEAUFORT SEA

COASTAL HABITATS

Coastal habitats in the BEAU OCS Planning Area include the mainland shores of the Chukchi and Beaufort Seas, from 160°W near Wainwright, to the U. S.-Canada border at 141 "W. The continents] shelf in this region is narrow (55-80km), averaging 64m deep (Feder et al. 1976). Tidal ranges are quite small (only about 15cm), but occasional late summer storm surges raise sea level from 1.5-3.0m above normal, inundating coastal tundra up to 1.2km inland (Hopkins and Hartz 1978). Discontinuous, but extensive, chains of small barrier islands that partially enclose a number of productive bays, sounds, and lagoons which provide large areas of shallow, biologically important habitat.

Beaches are mostly narrow, ranging from non-existent to about 33m wide, and consist of thin layers of sand and gravel overlying peat and mud permafrost, Low (<8m) peat bluffs line much of the shore in BEAU. These bluffs are eroding rapidly (0.2 ->20m·yr^{-1}) due to seasonal melting of the permafrost matrix and undercutting by seawater, Beaches are covered by ice and snow from early autumn to late spring (Hopkins and Hartz 19'78).

Boulder beaches occur on the western side of the Sagavanirktok Delta, at Point Brower, on Tigvariak Island and the Niakuk Islands, but rocky shores are otherwise absent in BEAU (Hopkins and Hartz 19'78; MMS 1983e). These small areas of boulders account for less than 1% of the total linear shoreline.

Offshore and barrier islands in this Planning Area are low (<3m), and most are covered by sand and gravel with vegetation sparse or absent. A few islands, covered mostly by peat, are remnants of the receding coastal plain (Hopkins and Hartz 1978).

There are several river deltas in BEAU with large areas of sand islands, salt marshes, and tidal flats, which are seasonally important to waterfowl and shorebirds (Seaman et al. 1981). The largest of these are the Colville and Sagavanirktok Deltas. The driftwood-strand line shown on ADFG (1981c) coastal habitat maps suggests that. virtually the entire coast of BEAU could be considered "wetland." However, the strand line results from infrequent storm surges, and a conservative estimate of linear wetland extent would include only the river deltas, or approximately 8-10% of linear shoreline.

River discharges and coastal peat erosion deliver large amounts of organic detritus to shallow, nearshore waters in BEAU. Schell and Horner (1981) estimated that 86% of the organic carbon inputs to Harrison Bay within the 10m isobath were from terrestrial sources, and only 14% from marine primary production. Over the total Alaskan Beaufort Sea (<10m), particulate organic carbon inputs were 4.6×10^8 kg·yr^{-1}, of which 5T% was derived from river discharge and coastal erosion, and 47% from marine primary production. Studies of naturally occurring carbon isotopes (Schell and Horner 1981) suggested that peat-derived carbon is important to higher trophic levels (fish). Other reports have indicated that peat is not a significant carbon source in marine food chains, but instead contributes important amounts of nutrients, especially nitrogen, to primary producers in the nearshore marine environment (Houghton et al. 1984).

There are a few isolated kelp beds in shallow waters with suitable rocky substrate. The best known of these is the Boulder Patch in Stefannson Sound (MAP #170), where the dominant kelp species (Laminaria solidungula) produces $7 gC \cdot m^{-2}$ annually, or $1.4 \times 10^8 gC \cdot yr^{-1}$ over the area of growth (MMS 1983e). Biomass measurements of macroalgae in the Boulder Patch ranged from 1.8 to $3.3 kg \cdot m^{-2}$ (wet weight, apparently), 80% of which was L. solidungula. This species completes 90% of its linear growth in total darkness under turbid ice, apparently storing photosynthetic products during the short season when light reaches the bottom, and taking advantage of high nutrient concentrations during the months of darkness (Dunton and Schonberg 1980). The Boulder Patch kelp beds support a rather unique epifaunal community (otherwise rare in BEAU because of the general lack of suitable habitat; Feder, et al 1976), and have been the object of intensive study (e. g., Broad, et al 1981). Kelp beds and macro algae have also been reported near Peard Bay (MAP #162), in Simpson Lagoon (MAP #168), and at other isolated locations in BEAU (Feder et al. 1976)

Salt marshes apparently occur in many areas of BEAU, with some of the mosl extensive found in southern Harrison Bay, the Colville River Delta, and the Fish Creek Delta (Connors et al. 1981; Lowry and Frost 1981b). Dominant wetland plant species are sedges (Carex spp.) and the emergent grass Arctophila fulva (Seaman et al. **1981).** No quantitative data on the areal extent or productivity of salt marshes have been found for this region.

Although intensive ecological and environmental asse ssment stu dies have been performed at a few specific sites in BEAU, much of the area, particularly east of the Canning River remains very poorly known in terms of habitats and ecological associations. Truett (1$380) concluded that biological productivity data from Simpson Lagoon were applicable to the entire Beaufort Sea coast because of morphological similarities and the generally linear nearshore movement of water currents, sediment transport, and migrant animal populations.

AEIDC. 1976.
(Arctic Environment Information & Data Center).
Profiles of the physical, biological and human environments of the Alaskan Outer Continental Shelf lease areas.
Univ. AK. Anchorage, AK. 31pp.

ALASKA: SHUM CKIN
Keywords: Coastal Morphology; Biotic Resources; Human Environments.

Very general and somewhat dated overviews of the Alaska OCS environment are subdivided by planning areas in this report.

AGAACL. 1981.
(AK Governor's Agency Advisory Committee On Leasing).
A social, economic and environmental analysis of a proposed oil and gas lease sale in Lower Cook Inlet.
State of Alaska. 150pp. + appendices.

ALASKA: CKIN
Keywords: Marine mammals; Birds; Finfish; Shellfish.

The section on "Resource Utilization Factors" contains discussions of wildlife habitats, distribution and abundance.

ALASKA DEPT. FISH & GAME. 1979b.
Recommendations for minimizing the impacts of hydrocarbon development on the fish, wildlife, and aquatic plant resources of Lower Cook Inlet. Inventory maps 1-8. Impact maps A-I. 1:250,000.
Ak Dept. Fish & Game, Marine/Coastal Habitat Management.
Anchorage, AK.

ALASKA: CKIN
Keywords: Birds; Mammals; Shellfish.

Maps contain text describing habitats, biota, and resource issues.

ALASKA DEPT. FISH & GAME. 1981a.
Chukchi basin proposed federal lease sale. Maps.
1. summer ; 2. winter. --1,1,000,000.
AK Dept. Fish & Game, Marine/Coastal Habitat Management,
Anchorage, AK.

ALASKA : CHKS
Keywords: Birds; Mammals;
Endangered Species.

Two maps with summary text describe physical and biological environment of CHKS and northern HBAS.

ALASKA DEPT. FISH & GAME. 1981b.
Major North Slope Wildlife Resource Issues Map and
Major North Slope Oil. and Gas Lease Areas Map. 1:750,000.
(including qualifier text).
AK Dept. Fish & Game. Anchorage, AK.

ALASKA : CHKS
Keywords: Birds; Mammals;
Endangered species.

Two maps show wildlife and development aspects of northern Alaska. Qualifying text accompanies.

ALASKA DEPT. FISH & GAME. 1981(-.
Mid-Beaufort Coastal habitat Evaluation Study:
Colville River to Kuparuk River. 8 Maps. 1:63,360.
AK Dept. Fish & Game, Marine/Coastal Habitat Management.
Anchorage, AK.

ALASKA : BEAU
Keywords: Habitats; Birds;
Fish; Mammals.

Black and white graphics depict coastal and inland habitats and biotic resources for a portion of the BEAU planning area. See Seaman et al . 1981 for accompanying text.

ALASKA DEPT. FISH & GAME. 1981e.
Recommendations for minimizing the impacts of hydrocarbon development on the fish, wildlife, and aquatic plant resources of the northern Bering Sea and Norton Sound. Maps 1-8, A-I. 1:500,000.
AK Dept. Fish & Game, Habitat Division. Anchorage, AK.

ALASKA : NORB

ALASKA DEPT. FISH & GAME. 1982a.
Environmental sensitivity and marine productivity of the Alaskan outer continental shelf: Contribution to the Governor's report on the Alaskan outer continental shelf. (Bibliographer's note: A collection of anonymous papers).
AK Dept. Fish & Game. Anchorage, AK. (unpaginated).

ALASKA : KODK
Keywords: Birds; Mammals;
Finfish; Benthos.

The coastal environments for six OCS regions in Alaska: Southern Bering Sea, central Bering Sea, Navarin Basin, northern Bering Sea - Norton Sound, Chukchi Sea, and Beaufort Sea are described. Population and harvest statistics for fish, birds, and mammals are valuable for some planning areas (eg. BEAU), but too broadly based for others (eg. GOAK).

ALASKA DEPT. FISH & CAME. 1984a.
Alaska coastal habitat maps. 1:250,000.
AK Dept. Fish & Game, Habitat Division. Anchorage, AK.

ALASKA: GOAK CKIN KODK HBAS
BEAU CHKS SMHL NORB
Keywords: Birds; Mammals;
Finfish.

A set of quadrangle maps for the entire coast of Alaska show important biological features, especially mammal distributions.

ARNESON, P. D.. 1980.
Identification, documentation and delineation of coastal migratory bird habitat in Alaska. Final report, NOAA/BLM, OCSEAP. Boulder, co. Contract No. 03-5-022-69.
AK Dept. Fish & Game. Anchorage, AK.

ALASKA : GOAK KODK
Keywords: Birds; Distribution; Abundance; Critical Habitats.

Density maps by species and season for marine and coastal birds, organized by OCS planning areas include descriptive information on coastal habitats from the eastern Gulf of Alaska to the North Alaskan Penninsula.

BANSE, K.. 1973.
Global distribut on of organic production in the oceans.
pp.38 - 48 In: T s. English (ed.).
Ocean Resources and Public Policy.
Univ. WA Press. Seattle, WA. 184pp.

PACIFIC: ORWA
Keywords: Annual production; Review.

This report is a very general review of marine primary production, but does provide estimates of coastal and offshore annual production for ORWA.

BARBOUR, M. G. & A. F. Johnson. 1977.
Beach and dune.
pp.223 - 261 In: M. G. Barbour & J. Major (ed.).
Terrestrial Vegetation of California.
John Wiley & Sons. New York.

PACIFIC: NCAL

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BARSDATE, R. J. , M. Nebert,
& C. P. Mc Roy. 1974.
Lagoon contributions to sediments and water of the
Bering Sea. Chapt. 28.
pp.553 - 576 In:D. W. Hood & E. J. Kelley (ed.).
Oceanography of the Bering Sea with emphasis on
Renewable Resources.
Univ. AK Inst. Marine Science. Fairbanks, AK.
Occas. Publ. No.2.

ALASKA: SGBA NABA
PACIFIC: ORWA
Keywords: Macrophytes ; Productivity;
Nutrient Export.

Izembek Lagoon eelgrass meadows produce 166,000 metric tons per yr. of Poe, most of which is exported to the Bering Sea Shelf, along with N and P. Lagoon detrital C,N, and P may be important in Bering Sea foodwebs. Only a small fraction of eelgrass production is decomposed with in the lagoon.

BECCASIO, A. D., G. H. Weissberg,
A. E. Redfield, R. L. Frew, W. M. Levitan, J. E. Smith,
& R. E. Godwin. 1980.
Atlantic coast ecological inventory and user's
guide and information base.
USFWS > Office of Biological Services. Washington, D.C.
FWS/OBS - 80/51. 163pp.

ATLANTIC: NATL SATL
Keywords: Marine birds; Endangered species;
Mammals; Fish; Habitats.

This report provides detailed information on distribution of animals and plants of the Atlantic coast, with emphasis on species of special concern. Valuable for vertebrates and conspicuous species, less so for invertebrates and less showy species.

BECCASIO, A. D., J. S. Isakson,
A. E. Red field, W. M. Blaylock, H. C. Finney, R. L. Frew,
D. C. Lees, D. Petrula, & R. E. Godwin. 1981.
Pacific coast ecological inventory user's guide and information base.
USFWS, Biological Services Program. Washington, D.C.
FWS/OBS - 81/30. 159pp.

PACIFIC: CCAL NCAL ORWA
Keywords: Geomorphology; Mammals;
Endangered Species.

As a companion to ecological inventory map series, text includes detailed lists of refuges and managed areas, and accounts of endangered species.

BIGELOW, G. W.. 1977.
Primary productivity of benthic microalgae in the Newport River estuary.
M.S. Thesis. NC State Univ. Raleigh, NC. 44pp.

ATLANTIC: SATL
Keywords: Estuaries; Primary production.

This thesis is a dated but useful summary of seasonal dynamics in benthic microalgal production.

BITTAKER, H. F.. 1975.
A comparative study of the phytoplankton and benthic macrophyte primary productivity in a polluted versus an unpolluted coastal area.
Ms. Thesis. Fl. State Univ. 167 pp.

GULF OF MEXICO: EGUL CGUL
Keywords: Annual. Cycle; Primary production;
Phytoplankton; SAV; Florida.

This thesis compares productivity (carbon-14 method) and biomass (chlorophyll 'a') for a polluted and relatively clean Florida estuary. Seasonal and annual productivity data are provided.

BITTAKER, H. F. & R. L. Iverson. 1976.
'Thalassia testudinum' productivity: A field comparison of measurement methods.
Mar. Biol. 37: p.39 - 46.

GULF OF MEXICO: EGUL
Keywords: Macrophyte Production; 'Thalassia'; SAV; Method Comparison; Northeast Gulf of Mexico.

Two methods for measuring 'Thalassia testudinum' productivity are compared for a north Florida seagrass bed. Results indicate that the Zieman staple technique results in higher rates than the carbon-14 radiotracer technique.

BRIGHT, D. B.. 1974.
Benthic invertebrates. Chapt. 10.
pp.1 - 291 In: M. D. Dailey, B. Hill & N. Lansing (cd.).
A Summary of Knowledge of the Southern California Coastal Zone & Offshore Areas. Vol.II. Biological Environment. Performed for BLM. Contract No. 08550-CT4-1.
The So. CA. Ocean Studies Consortium.

PACIFIC: SCAL

Major benthic invertebrates and their locations in the southern California borderland are reported. Occurrence, amount, and relative abundance information for intertidal to continental slope species are presented and discussed. Literature is cited by topic and date from the 1930's until 1974.

BROAD, A. C. , M. Childers,
K. Dunton, J. Hanes, H. Koch, D. E. Schneider,
S. Schonberg, & J. Zehr. 1981.
Environmental assessment of selected habitats in
arctic littoral systems.
pp.401 - 620 In: NOAA, Office of Marine Pollution Assessment (cd.).
Environmental Assessment of the Alaskan Continental Shelf.
Ann. repts. of principal investigators for the yr. ending
Mar. 1981. Vol.I: Receptors - Birds, fish, marine mammals,
plankton, littoral- Prepared for BLM. Washington, D. C.

ALASKA : BEAU
Keywords: Macroalgae; Benthos;
Biomass; Productivity.

Intensive studies of the flora and fauna of the Stefannson Sound "Boulder Patch" kelp community are reported. Included are kelp production estimates,

BUREAU OF LAND MANAGEMENT. 1975b.
Final environmental statement 75: Proposed
increase in oil and gas leasing on the outer
continental shelf.
BLM. Washington, D. C.
3 Vols. 2752pp.

ALASKA : KODK

Environmental Impact Statement covers all OCS regions.

BUREAU OF LAND MANAGEMENT. 1981a.
Lower Cook Inlet - Shelikof Strait. Proposed Oil and
Gas Lease Sale 60. Final Environmental Impact Statement.
BLM, Alaska OCS Office.
1 Volume, supplement , and 16 graphics.

ALASKA: GOAK CKIN KODK
Keywords: Finfish; Mammals;
Birds; Shellfish.

EIS includes color graphics showing distributions of marine and coastal birds, mammals, endangered species, finfish, and she] lfish resources of Cook Inlet and Kodiak areas.

BURNS, J. J., L. IH. Shapiro, & F. F. Fay. 1981a.
The relationships of marine mammal distributions, densities and activities to sea ice conditions.
pp.489 - 670 In: NOAA, Office of Marine Pollution Assessment, Fairbanks, AK. (eds.).
Environmental Assessment of the Alaskan Continental Shelf. Final reports of principal investigator-s. Vol.11. Biological studies. Prepared for BLM. Washington, D.C.

ALASKA: HBAS CHKS
Keywords: Marine Mammals; Distribution; Abundance; Migration; Habitats.

Most of this paper is concerned with analysis of ice distribution and morphology . Marine mammal distributions and abundance are classified by seasons, ice types, and OCS planning areas.

CALVIN, N. I.. 1981.
Some benthic marine algae from the Pribilof Islands, Bering Sea: A preliminary annotated list. Appendix III. In: O' Clair, et al. Reconnaissance of intertidal communities in the eastern Bering Sea and the effects of ice-scour on community structure.
pp.393 - 413 In: NOAA, Office of Marine Pollution Assessment (cd.). Environmental Assessment of the Alaskan Continental Shelf, Final reports of principal investigators. VO1.10. Biological studies. Prepared for BLM. Washington, D.C.

ALASKA : SGBA

Though primarily a species list, a short description of the subtidal macroalgal community is presented.

CALVIN, N. I. & R. J. Ellis. 1981.
Growth of subtidal 'Laminaria groenlandica' in south eastern Alaska related to season and depth.
Botanica Marina 24 :p.107 - 114.

ALASKA: GOAK SHUM SGBA

Report contains some caluable descriptive infot-mation about kelp distribution and abundance in southeastern Alaska. Unfortunately, growth is reported only in linear units rather than biomass or carbon.

CLARK, J. R.. 1977.
Coastal Ecosystem Management.
John Wiley & Sons. New York. 928pp.

PACIFIC: SCAT.. CCAL NCAL

Information in this text is interesting and useful, but somewhat dated. Extensive summaries are provided of coastal management issues, case histories, and possible solutions.

CONNORS, P. G., S. R. Johnson,
& G. J. Divoky. 1981.
Birds. Chapt. 1.5.
pp.39 - 42 In: D. W. Norton & W. M. Sackinger (ed.).
Beaufort Sea (Sale 71) Synthesis Report. Proceedings of a synthesis meeting, Chena Hot Springs, AK, April 21-23, 1981.
NOAA/BLM, OCSEAP. Juneau, AK.

ALASKA: BEAU
Keywords: Birds; Distribution;
Abundance.

A brief but detailed account of coastal birds and their habitats in the Harrison Bay vicinity of arctic Alaska is included in this chapter.

CONOVER, J. T.. 1968.
Importance of natural diffusion gradients and transport of substances related to benthic marine plant metabolism.
Bet. Mar. 11 :p.1 - 9.

ATLANTIC : NATI .
Keywords: SAV; 'Zostera marina';
Daily production rates; Rhode island.

CUB IT, J. D. . 1984.
Herbivory and the seasonal a bundance of algae on a high rocky intertidal shore.
Ecology 65 :p .1904 - 1917.

PACIFIC: ORWA
Keywords: Benthos; Algal Productivity.

Limpet grazing and desiccation reduces algal biomass in the Oregon high rocky intertidal during summer, but winter growth is heavy. Biomass and descriptive information for a seldom-studied component of the shore community.

D'ANTONIO, C.. 1985.
Epiphytes on the rocky intertidal red algae 'Rhodomela larix' (Turner) C. Agardh: Negative effects on the host and food for herbivores?
J. Exp. Mar. Biol. Ecol. 86 :p.197 - 218.

PACIFIC: ORWA
Keywords: Macroalgae; Productivity.

An unusual investigation of relative biomass and productivity of epiphytes on macroalgae provides biomass ratios suggesting that production is quite significant.

DAVIS, G. J. & D. F. Carey, Jr.. 1981.
Trends in submerged macrophyte communities of the Currituck Sound: 1977-1979.
J. Aquat. Plant Managemt.]9 :p.3 - 8.

ATLANTIC: MATL
Keywords: Macrophytes; SAV;
North Carolina; Biomass.

This paper details distribution and abundance of macrophytes in Currituck Sound. Valuable for species-by-species analysis over a five year interval assessment of below-ground biomass of Eurasian water milfoil.

DAVIS, R. A. & J). H. Thomson. 1984.
Marine mammals. Chapt.4
pp.47 - 79 In: J. C. Truett (ed.).
The Barrow Arch Environment and Possible Consequences of Planned Offshore Oil and Gas Development. Proceedings of a synthesis meeting, Girdwood, AK, 30 Ott - 1 Nov 1983.
NOAA/MMS, OCSEAP. Juneau, AK.

ALASKA : CHKS HBAS
Keywords: Distribution; Abundance;
Migration; Endangered Species; Mammals.

Distribution maps and species accounts for marine mammals in the Chukchi Sea includes a discussion of mammal sensitivity to development .

DAWES, C. J.. 1981.
Marine Botany.
John Wiley & Sons. New York. 628pp.

PACIFIC: SCAL

This text incorporates ecological and physiological concepts and attempts to provide a general picture of plant adaptation to marine systems. Its strength is in detailed coverage of algae, weakness is in nearly ignoring organismal aspects of marine and estuarine angiosperms .

DE LA CRUZ, A. A.. 1974.
Primary productivity of coastal marshes in Mississippi.
Gulf Resources Rept. 4 :p.351 - 356.

GULF OF MEXICO: CGUL WGUL
Keywords: Marsh; Primary production;
'Saggittaria falcata'; Salt Marsh.

This paper provides a concise summary of production values in nine distinct types of coastal marshes. Though somewhat dated, it is unique for its interhabitat comparison.

DE LA CRUZ, A. A. & C. T. Hackney. 1977.
Energy value, elemental composition and productivity of belowground biomass of a 'Juncus' tidal marsh.
Ecology 58 :p.1165 - 1170.

GULF OF MEXICO: EGUL
Keywords: 'Juncus' ; Belowground Biomass; Salt marsh.

This paper summarizes production, energetic values and elemental composition of below-ground portions of a 'Juncus' tidal marsh. It is a valuable contribution to this poorly understood component-.

DELAUNE, R. D., W. H. Patrick, Jr., & R. J. Buresh. 1979.
Effect of crude oil on a Louisiana 'Spartina alterniflora' salt marsh.
Envir. Pollution 20 :p.21 - 31.

GULF OF MEXICO: CGUL
Keywords: 'Spartina alterniflora' ; Crude oil effects; Production; Soil processes; Salt marsh.

Effects of varying concentrations of crude oil on growth of 'Spartina alterniflora' and salt marsh soil processes were evaluated. Productivity of 'S. alterniflora' and biological soil processes (i.e. reduction of nitrate, manganese, iron, and sulfate and production of methane and ammonium) were measured.

DELONG, R. 1... 1978.
Northern elephant seal.
pp.207 - 211 In: D. Haley (ed.).
Marine Mammals of Eastern North Pacific and Arctic Waters.
Pacific Search Press. Seattle, WA. 256pp.

PACIFIC: ORWA
Keywords: Marine Mammals ; Distribution; Abundance ; Life History.

The absence of breeding north of the Farallon Islands, but occurrence of extensive feeding offshore Oregon, Washington, and British Columbia by elephant seals are reported in this chapter.

I) ENNISON, W. C. & R. S. A] berte. 1982.
Photosynthetic responses of 'Zostera marina '
(eelgrass) to 'in situ' manipulations of light intensity.
Oecologia 55 :p.137 - 144.

ATLANTIC: NATL
Keywords: Light intensity; SAV;
'Zostera marina' ; Massachusetts; Daily production rates.

'In situ' experiments were conducted in Great Harbor, MA to examine responses of 'Zostera marina' to various light intensities. Photon flux density was manipulated in shallow and deep stations ***over*** a 1 to 2 week period.

DRURY, W. H., C. Ramsdell,
& J. B. French, Jr.. 1981.
Ecological studies in the Bering Strait Region.
pp.175 - 487 In: NOAA, Office of Marine Pollution Assessment (cd.).
Environmental Assessment of the Alaskan Continental Shelf.
Final reports of principal investigators. Vc>l.11.Biological studies. Prepared for BLM. Washington, D.C.

ALASKA : NORB HBAS CHKS
Keywords: Birds; Abundance;
Ecology; Distribution.

Though rambling and idiosyncratic, this report contains valuable first hand accounts of coastal habitats in the Kotzebue Sound region , as well as bird density maps and colony counts.

D UNTON, K. H. & S. V. Schonberg. 1980.
Ecology of the Stefannson Sound kelp community:
Preliminary results of 'in situ' and benthic studies.
pp.366 - 412 In: NOAA, Office of Marine Pollution Assessment,
Rockville, MD. (eds.).
Environmental Assessment of the Alaskan continental shelf.
Ann. repts. of principal investigators for the yr. ending
Mar. 1980. Vol. I: Receptors- Birds, plankton, littoral,
benthos. Prepared for BLM. Washington, D.C.

ALASKA: BEAU
Keywords: Kelp; Invertebrates;
Growth; Productivity.

The most interesting aspect of this report is the discovery of winter growth of 'Laminaria solidungula' under turbid ice.

EILERS, H. D.. 1979.
Production ecology in an Oregon coastal salt marsh.
Est. Cstl. Mar. Sci. 8 :p.399 - 410.

PACIFIC: SCAL

ELEUTERIUS, L. N.. 1981.
The marine flora of Mississippi Sound: A review.
pp.21 - 27 In: J. R. Kelley (ed.).
Symposium on Mississippi Sound.
MS-AL Sea Grant Consortium.
NOAA #NA-81-AA-D-00050. 152pp.

GULF OF MEXICO: CGUL
Keywords: Macrophyte; Distribution;
Identification; Barrier islands; Algae.

This chapter provides a concise summary of distribution and habitat relationships of macrophytic vegetation of the Mississippi barrier islands.

FAY, F. H.. 1981.
Modern populations, migrations, demography, trophics and historical status of the Pacific walrus. Annual Report. pp.191 - 234 In: NOAA, Office of Marine Pollution Assessment (cd.). Environmental Assessment of the Alaskan Continental shelf. Annual repts. of principal investigators for the yr. ending Mar 1981 . Vol.I: Receptors - Birds, fish, marine mammals , plankton, littoral. Prepared for BLM. Washington, D.C. NOAA , OCSEAP. Juneau, AK.

ALASKA: SMHL NABA
Keywords: Distribution; Abundance; Ecology; Mammals.

An exceptionally clear and useful report contains the first detailed accounts of Walrus Wintering distribution, behavior, and population status in the northern Bristol Bay area.

FEDER, H. M., D. G. Shaw, & A. S. Naidu. 1976.
The arctic coastal environment of Alaska. Vol. II. A compilation & review of scientific literature of the arctic marine environment. Univ. AK Inst. Marine Science. Fairbanks, AK. IMS Rept. R76-5/Sea Grant Rept. 76-9. 201pp.

ALASKA : BEAU
Keywords: Geomorphology; Macrophytes.

FRANKENBERG, D. & A. S. Leiper. 1977.
Seasonal cycles in benthic communites of the Georgia continental shelf. pp.383 - 397 Tn: B. C. Coull (cd.). Ecology of Marine Benthos. Univ. SC Press. Columbia, SC. 467pp.

ATLANTIC: SATL
Keywords: Continental shelf; Mollusks; Amphipods; Polychaetes; Benthos.

This chapter summarizes a series of quantitative samples from soft bottoms on the south Atlantic continental shelf. It is valuable for species lists and density data.

FRITTS, T. H., A. B. Irvine,
R. D. Jennings, L. A. Collum, W. Hoffman & M. A. Mc Gehee. 1983.
Turtles, birds, and mammal s in the nort hern Gul f
of Mexico and nearby Atlantic waters.
MMS/ USFWS, Office of Biological Services. Washington, D.C.
FWS/OBS 82/65. 465pp.

ATLANTIC: SATL
GULF OF MEXICO: EGUL CGUL WGUL
Keywords: Mammals; Turtles;
Birds; Overflight surveys; Beaches.

Report summarizes study of seasonal distribution and abundance of marine turtles, birds, and mammals observed from aircraft surveys from April 1980 through April 1981. Species accounts include description, and geographical, seasonal, and ecological variation in distribution and abundances. Discussions of geographical, seasonal, and ecological trends relevant to the areas studied are arranged in separate sections. Potential impacts of OCS development are 'discussed and vulnerability indexes for populations and individuals are developed (which can be used for risk evaluation). Plots of distribution are included.

GALLAGHER, J. L. , R. J. Reimold,
R. A. Linthurst, & W. J. Pfeiffer. 1980.
Aerial production, mortal i tv and millers] .accumula-
tion - export dynamics in 'Spartina alterniflora' and
'Juncus roemerianus' plant stands in a George salt marsh.
Ecology 61 :p.303 - 312.

ATLANTIC: SATL
Keywords: Salt marsh; Macrophyte ;
Primary production; 'Spartina alterniflora'.

This paper compares marsh - dominant macrophytes as sources and sinks of carbon and nutrients.

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CALLAWAY , B. J. . 1981.
An ecosystem analysis of oil and gas development on the Texas - Louisiana continental shelf.
USFWS , Office of Biological Services. Washington, D.C.
FWS/OBS 81/27. 88pp.

GULF OF MEXICO: CGUL WGUL
Keywords: Beaches; Sublittoral habitats.

This report provides a systems-level overview of ecology and potential response to petroleum development of the western Gulf of Mexico continental shelf. It is useful for its linkage of abiotic and biotic parameters.

GAROFALO, D.. 1982.
Mississippi Deltaic Plain Region ecological characterization : An ecological atlas. Map narratives and map numbers A-1 through F-13.
USFWS , Office of Biological Services. Washington, D.C.
FWS/OBS - 81/16.

GULF OF MEXICO: CGUL
Keywords: SAV.

This map series provides a detailed, large-scale view of ecologically relevant aspects of the Mississippi delta. Valuable, but the scale suggests it will date quickly.

GEOLOGICAL SURVEY OF ALABAMA. 1976.
Alabama Coastal Marsh Inventory- Maps.
1:24,000; 1:12,000.
AL Coastal Area Board. Montgomery, AL.
Rept. NO. ALA-ADO-X996-CZM-1 1.

GULF OF MEXICO: EGUL
Keywords: Salt marsh.

This is a dated but detailed summary of' coastal marsh distribution in Alabama.

GILBERT, S. & K. B. Clark. 1981.
Seasonal variation in standing crop of the seagrass 'Syringodium syringodium filiforme' and associated macrophytes in the North Indian River, Florida.
Estuaries 4 :p.223 - 225.

ATLANTIC: SATL
Keywords: Macrophyte; SAV;
Indian River, FL; biomass.

This paper provides information on seasonal changes in biomass of submerged aquatic vegetation associated with 'Syringodium' beds in a Florida estuary.

GILLELAN, M. E., D. Haberman,
G. B. Mackiernan, J. Macknis, & H. W. Wells, Jr.. 1983.
Chesapeake Bay: A framework for action.
EPA, Chesapeake Bay Program. Annapolis, MD.
186pp. with separate volume of appendices.

ATLANTIC: MATL
Keywords: SAV; Chesapeake Bay.

GIURGEVICH, J. R. & E. L. Dunn. 1982.
Seasonal patterns of daily net photosynthesis, transpiration and net primary productivity of 'Juncus roemerianus ' and 'Spartina alterniflora' in a Georgia salt marsh.
Oecologia (berl) 52 :p.404 - 410.

ATLANTIC : SATL
Keywords: Macrophyte ; Salt Mat-sh Production;
Above & Belowground; 'Spartina alterniflora' .

This paper analyzes net production of marsh - dominant macrophytes by gas - exchange methods . It provides an interesting comparison of aerial and below - ground production.

GOOD, R. E. & N. F. Good. 1975.
Vegetation and production of the Woodbury Creek - Hessian Run freshwater tidal marshes.
Bartonia 43 : p.38 - 45.

ATLANTIC: MATL
Keywords: Production; Freshwater marsh.

GOOD, R. E., N. F. Good, & B. R. Frasco. 1982.
A review of primary production and decomposition dynamics of the belowground marsh component.
pp.139 - 157 In: V. Kennedy (ed.).
Estuarine comparisons.
Academic Press. New York.

PACIFIC; CCAL

GOSSELINK, J. G.. 1979.
An ecological characterization study of the Chenier Plain coastalecosystem of Louisiana and Texas.
USFWS . Biological Services Program. Washington, D.C.
FWS/OBS - 78/9-11.

GULF OF MEXICO: WGUL
Keywords: Marshes; Chenier Plain.

GRAY, J. S.. 1981.
The Ecology of Marine Sediments.
Cambridge Univ. Press. New York. 185pp.

PACIFIC: SCAL

This is a short review of ecology of soft marine bottoms. Concepts and general information are useful.

GUSEY,W. F. . 1979a.
The fish and wildlife resources of the western Gulf of Alaska.
Environmental Affairs, Shell Oil Co. Houston, TX.
334pp.

ALASKA: GOAK KODK CKIN SHUM
Keywords: Mammals; Birds;
Finfish; Distribution & Abundance Life History.

One of a series of elegant volumes describes biotic resources of the Alaskan marine environment. Unfortunately, some of the information is now out-of-date.

GUSEY, W. F.. 1979b.
The fish and wildlife resources of the southern Bering Sea region.
Environmental Affairs, Shell Oil Company. Houston, 'J-X.
383pp.

ALASKA : NABA NORB SGBA SMHL
Keywords: Wildlife; Finfish;
Distribution; Harvest; Abundance.

vide Gusey 1979a

HANES, T. L.. 1981.
California chaparral.
pp.139 - 174 In: F. diCastri, D. W. Goodall, & R. L. Sprecht (eds.).
Mediterranean Type Shrublands.
Elsevier Scientific Publishing Co. New York. 643pp.

PACIFIC: SCAL

This chapter is updated and more process-oriented, but otherwise covers information similar to that provided by Hanes 1977.

HARDING, L. W. & J. H. Butler. 1979.
The standing stock and production of eelgrass 'Zostera marina', in Humboldt Bay, California.
Ca Fish Game 65 :p.151 - 158.

ALASKA: CKIN
Keywords: Macrophytes; Biomass; Productivity.

Eelgrass production is compared with phytoplankton productionon an areal basis. Biomass estimates for Humboldt Bay are given.

HEALEY, F. P.. 1972.
Photosynthesis and respiration of some arctic seaweeds.
Phycologia 11 :p.267 - 271.

ALASKA : SMHL
keywords: Macroalgae ; Productivity.

Measurements of photosynthesis and respiration on three species of macroalgae ('Halosaccion' sp., 'Fucus' sp., and 'Laminaria' Sp.) collectedfrom Nunivak Island indicated that net growth could take place at 0 degrees centigrade or less under 70cm of ice from which snow had been removed. A rare reference to macroalgae of the Bering Sea.

HEDGEPETH, J. W.. 1968.
Between Pacific Tides.
Stanford Univ. Press. Stanford, CA. 614pp.

PACIFIC: SCAL NCAL

This is a popular guide to Pacific intertidal organisms. Scientific usefulness is limited

HELLMERS, H. , .1. Bonner,
& J. M. Kelleher. 1955.
Soil fertility: A watershed management problem in the San Gabriel Mountains of Southern California.
Soil Science 80 :p.189 - 197.

PACIFIC: SCAL

This thirty year old report is still a useful reference for problems of watershed management in coastal Californinia.

HO, J.. 1974.
Marshes and bays.
pp.1 - 59 In: M. D. Dailey, B. Hill, & N. Lansing (ed.).
A Summary of Knowledge of the Southern California Coastal Zone and Offshore Areas. Vol. II. Biological Environment.
B LM. Contract No. 08550-CT4-1.
The So. CA Ocean Studies Consortium.

PACIFIC: SCAL

HODGSON, L. M. & J. R. Waaland. 1979.
Seasonal variation in subtidal macroalgae of Fox Island, Puget Sound, Washington.
Syesis 12 :p.107 - 112.

PACIFIC: SCAL

This paper provides some information on spatial and temporal changes in Pacific lithophytic algae communities.

HOPKINS, D. M & R. W. Hartz. 1978.
Coastal morphology, coastal erosion, and harrier islands of the Beaufort Sea, Alaska
u. s. Geological Survey.
Open File Report 78-1063. 58pp.

ALASKA : BEAU
Keywords: Geomorphology.

Very useful descriptions of Beaufort Sea beach substrates and permafrost peat bluffs are provided.

HO PKI SON, C. S. , J. G. Gosselink,
& R. T. Parrondo. 1978.
Abovegr ound production of seven marsh plant species
in coastal Louisiana.
Ecology 59 :p.760 - 769.

GULF OF MEXICO: CGUL WGUL
Keywords: Marshes; Production;
'Sagittaria falcata' ; Macrophytes.

Above-ground production of seven species of marsh plants from the Louisiana coast was evaluated for two years. Variability in evaluating production estimates is discussed.

HUMM, H. J.. 1973.
The biological environment: a) salt marshes,
b) benthic algae, c)seagrass, d) mangrove.
pp.1 - 5 In: J. I. Jones, R. E. Ring, M. D. Rinkel,
M. D. Rinkel, & R. E. Smith (eds.).
A summary of the knowledge of the eastern Gulf of Mexico.
State Univ. System of FL, Institute of Oceanography.
St. Petersburg, FL.

GULF OF MEXICO: EGUL CGUL
Keywords: SAV; Production;
Mangrove; Salt marsh; Biscayne Bay.

An enumeration of the major species of plants is presented for salt marshes, benthic algae, seagrasses, and mangroves of the eastern Gulf of Mexico. Factors governing the distribution of plants in each habitat are discussed and basic production values are given.

JOHNSON, K. R. & C. H. Nelson. 1984.
Side-scan sonar assessment of gray whale feeding in the Bering Sea.
Science 225 :p.1150 - 1152.

ALASKA : SMHL NORB
Keywords: Benthos; Ecology;
Sedimentology ; Nutrient Cycling; Mammals.

An analysis of the importance of gray whale feeding to sedimentology and nutrient cycling in the northern Bering Sea includes an estimate of the contribution of ampeliscid amphipod concentrations in the area to gray whale food requirements.

JOHNSON, W. S., A. Gigon,
s. L. Gulmon, & H. A. Mooney. 1974.
Comparative photosynthetic capacities of intertidal algae under exposed and submerged conditions.
Ecology 55 :p.450 - 453.

PACIFIC: ORWA
Keywords: Macroalgae; Productivity.

Net carbon dioxide uptake measured in air and water for five speices of macroalgae showed high photosynthetic rates under both conditions.

JONES & STOKES ASSOCIATES, INC.. 1981a.
Sacramento, CA.
An ecological characterization of thecentral and northern California coastal region. Vol.II , Part 2. Species.
Performed for BLM, Pacific OCS Office.
USFWS, Office of Biological Services. Washington}, D.C.
FWS/OBS - 80/49. 670pp.

PACIFIC: SCAL CCAL NCAL
Keywords: Marine mammals; Coastal environment;
Finfish; Phytoplankton; Benthos.

Detailed ecological information about major plant and animal species occurring in CCAL and NCAL is presented.

JONES & STOKES ASSOCIATES, INC. . 19811).
Sacramento, CA.
An ecological characterization of the central and northern California coastal region. Vol. III, Part 1. Habitats. Prepared for BLM, Pacific OCS Office. USFWS, Office of Biological Services, Washington, D.C. FWS/OBS-80/47.1. 463pp.

PACIFIC: SCAL CCAL NCAL
Keywords: Coastal environment; Benthos.

This volume provides detailed ecological information on major habitats that are found in CCAL and NCAL.

JOSSELYN, M.. 1983.
The ecology of San Francisco Bay tidal marshes: A community profile.
USFWS, Division of Biological Services. Washington, D.C. FWS/OBS-83/23. 102pp.

PACIFIC: CCAL
Keywords: Marshes.

KING, J. C. & C. P. Dau. 1981.
Waterfowl and their habitats in the eastern Bering Sea. Chapt. 42.
pp.739 - 753 In: D. W. Hood & J. A. Calder (cd.).
The Eastern Bering Sea Shelf: Oceanography and Resources. Vol.II. NOAA/BLM, Office of Marine Pollution Assessment. Washington, D.C. Distributed by: University of Washington Press, Seattle, WA.

ALASKA: NABA NORB SMHL
Keywords: Coastal Habitats; Numbers; Distribution.

Waterfowl population sizes and areas of habitat in the region are reported. The habitat descriptions are extremely valuable. Species accounts are included.

KIRBY, C. J. & J. G. Gosselink. 1976.
Primary production in a Louisiana Gulf coast
'Spartina alterniflora' marsh.
Ecology 57 :p.1052 - 1059.

GULF OF MEXICO: CGUL
Keywords : Primary Production; 'Spartina alterniflora';
Salt marsh; Louisiana.

This paper details seasonal and annual primary production of a
Louisiana 'Spartina' marsh based on harvest methods.

KNUTSON, P. L. & W. W. Woodhouse, Jr.. 1982.
Pacific coastal marshes.
pp.112 - 130 In: R. R. Lewis, III. (ed.).
Creation and Restoration of Coastal Plant Communities.
CRC Press. Boca Raton, FL. 219pp.

PACIFIC: SCAL

This is the best available review of knowledge of Pacific coast
marshes, with specific reference to restoration of this relatively
rare and poorly understood community.

KRAUSS, R. W. (ed.). 1977.
The marine plant biomass of the
Pacific northwest coast. Pacific
Northwest Regional Commission.
Oregon State University Press. 397pp.

PACIFIC: ORWA
Keywords : Macroalgae; Biomass;
Productivity; Geomorphology.

See individual authors for annotations.

KRUCZYNSKI, W. L., C. B. Subrahmanyam, & S. H. Drake. 1978.
Studies on the plant community of a north Florida salt marsh. Part I. Primary production.
Bull. Mar. Sci. 28 :p.316 - 334.

GULF OF MEXICO: EGUL
Keywords: Salt Marsh; Production;
'Juncus'; 'Distichlis'; 'Spartina'.

This paper summarized production of three vegetation communities in a gradient of inundation on a north Florida marsh ecosystem. It is valuable for its analysis of spatial variation in production parameters.

LADNER, C. M. & J. S. Franks. 1982.
Mississippi coastal waters. Mineral lease sale area No. 1. Environmental profile and environmental guidelines for activities associated with oil and gas drilling rigs and production platforms.
Dept. of Wildlife Conserv., Bur. of Marine Resources.
Long Beach, MS.

GULF OF MEXICO: CGUL
Keywords: Maps; Habitat;
Mississippi; Oysters.

Descriptions of coastal habitats and associated flora and fauna of the Mississippi coast are presented in relation to potential impacts of oil activities. "Sensitive" areas are defined by location and "buffer" zones are established around them.

LEES, D. & R. J. Rosenthal. 1977.
An ecological assessment of the littoral zone along the outer coast of the Kenai Peninsula for State of Alaska , Department of Fish and Game.
pp.277 - 476 In:
Environmental Assessment of the Alaskan Continental Shelf. Ann. repts. of principal investigators for the yr. ending Mar. 1977. Vol.VII. Receptors - Fish, littoral, benthos. NOAA/BLM, OCSEAP. Boulder, CO.

ALASKA: CKIN
Keywords: Macrophytes; Macroalgae; Distribution; Biomass.

A comprehensive account of macrophyte, macroalgal, and benthic invertebrate distribution, abundance , and biomass from previously unstudied, and probably represntative, locations on the central Gulf of Alaska coast is contained in this report.

LEWBEL, G. S.. 1984.
Environmental hazards to petroleum industry development . Chapt. 3.
pp.31 - 46 In: J. C. Truett (eel.).
The Barrow Arch Environment and Possible Consequences of Planned Offshore Oil and Gas Development . Proc. synthesis meeting, Girdwood, AK, 30 Oct - 1 Nov 1983.
NOAA/MMS, OCSEAP. Juneau, AK.

ALASKA : CHKS
Keywords: Geology; Sedimentology
Ice.

LEWBEL, G. S. & B. J. Gallaway. 1984.
Transport and fate of spilled oil. Chapt. 2
pp.7 - 29 In: J. C. Truett (ed.).
The Barrow Arch Environment and Possible Consequences of Planned Offshore Oil and Gas Development. Proceedings of a synthesis meeting, Girdwood, AK, 30 Ott - 1 Nov 1983.
NOAA/MMS, OCSEAP. Juneau, AK.

ALASKA : CHKS
Keywords: Geomorphology; Weather;
Ice; Oil Spill Transport.

LIPPINCOTT, W.H.. 1980.
Littoral zone biota. Chapt. 6
pp. 109 - 122 In: Science Applications, Inc. Boulder, CO. (ed.).
Environmental Assessment of the Alaskan Continental Shelf.
Northeast Gulf of Alaska Interim Synthesis Report prepared
Under The Guidance Of OCSEAP.
NOAA, Office of Marine Pollution Assessment. Juneau, AK.

ALASKA : SHUM GOAK
Keywords: Macroalgae; Benthos.

This chapter is a very good source of numerical data on beach substrates, macroalgal biomass, and density of benthic invertebrates for the northeastern Gulf of Alaska.

LITTLER, M. M.. 1978a.
The annual and seasonal ecology of Southern California rocky intertidal, subtidal and tidepool biotas,
Report 1.1.
In: Science Applications, Inc. (ed.).
Southern California Baseline Study, Intertidal, Year *Two.*
Final Report. Vol. III. ***Prepared*** for BLM, Pacific OCS
Office. Los Angeles, CA.

PACIFIC: SCAL
Keywords: Macrophytes.

Benthic fauna and flora of southern California are characterized in this study. Seasonal and annual abundance and composition fluctuations in tidepools, on offshore banks, and subtidal zones are discussed.

LITTLER, M. M. . 1978b.
Variations in the rocky intertidal biota near Dutch Harbor, San Nicolas Island, California, Report 1.1 .8. pp.1 - 79 In: Science Applications, Inc. (ed.). Southern California Baseline Study, Intertidal , Year Two. Final Report. Vol.III. Prepared for BLM, Pacific OCS Office. Los Angeles, CA.

PACIFIC: SCAL
Keywords: Macrophytes.

Productivity in surface waters in areas of upwelling above seaward basins is compared with productivity in landward areas without upwelling.

LITTLER, M. M.. 1980.
Southern California rocky intertidal ecosystems: Methods, community structure, and variability. pp.565 - 608 In: J. H. Price, D. E. G. Irvine, & W. F. Farnham (eds.). The Shore Environment, Vol. 2. The Systematic Association Special Vol. No. 17 (a). Academic Press. New York. 945pp. + indices.

PACIFIC: SCAL

This chapter in a symposium volume is unusual and valuable for its depth of coverage of rocky intertidal communities. It includes detailed summaries of qualitative (species composition) and quantitative (cover, biomass, and environmental parameters) data.

LITTLER, M. M. & S. N. Murray. 1974.
The primary productivity of marine macrophytes from a rocky intertidal community. Mar. Biol. 27 :p.131 - 135.

PACIFIC: SCAL CCAL NCAL
ATLANTIC: NATL
Keywords: Macroalgae; Productivity.

This paper provides methods and results of productivity studies on macroalgal kelps.

LTV INGSTON, R. J. . 1983.
Resource atlas of the Appalachicola Estuary.
FL Sea Grant College Program.
Rept. No. 55. 64pp.

GULF OF MEXICO: EGUL
Keywords: Estuarine; Habitats;
Fauna; Salt marsh.

Biological features of the Appalachicola Bay estuary, including marsh and submerged vegetation, faunal assemblages, and microbial processes are described in this atlas. In addition, physical-chemical features, management strategies, and economics of resources are discussed. Many color visuals support the text.

LONGLEY, W. 1.. , R. Jackson,
& B. Snyder. 1981.
Managing oil and gas activities in coastal environments : Refuge manual.
USFWS , Office of Biological Services. Washington, D.C.
FWS/OBS-81/22. 451pp.

GULF OF MEXICO: WGUL
Keywords: Chenier Plain; Marshes;
Habitats; Geomorphology; Impacts.

This report is an interesting and valuable compilation of parameters of importance for managing oil and gas activities near coastal refuge areas.

LOWRY, L. F. & K. J. Frost. 1981b.
Marine mammals. Chapt. 1.6.
pp.43 - 46 In: D. W. Norton & W. M. Sackinger (ed.).
Beaufort Sea (Sale 71)- Synthesis Report. Proceedings of a synthesis meeting, Chena HoI. Springs, AK. April 21-23, 1981
NOAA/BLM, OCSEAP. Juneau, AK.

ALASKA: BEAU
Keywords: Habitat Description; Impacts;
Sensitivity.

Chapter is a very brief account of important marine mammals in the Beaufort Sea.

LYNCH, M. P., B. L. Laird,
N. B. Theberge, & J. C. Jones (eds.). 1976.
An assessment of estuarine and nearshore
marine environments. Performed for the Office of Biological
Services, Fish & Wildlife Services, U.S. Department of the
Interior as part of the 1975 National Water Resources
Assessment.
VA Inst. Marine Science, Gloucester Point, VA.
SRAMSOE No.93 (revised). 132pp.

ATLANTIC: NATL SATL
GULF OF MEXICO: EGUL
PACIFIC: ORWA
Keywords: Human environments; Coastal;
Habitats; Estuaries; Impacts.

A synopsis of all U.S. coastal regions is presented. The synopsis includes a brief description of the coast, a review of the legal status of estuarine management, resources of estuaries, and impacts of predicted water resource uses.

MANN, K. H.. 1972,
Ecological energetic of the seaweed zone in a
marine bay on the Atlantic coast of Canada. II.
Productivity of the seaweeds.
Mar. Biol. 14 :p.199 - 209.

ALASKA: GOAK KODK CKIN SHUM
SGBA NORB
Keywords: Kelp; Production.

Annual production of kelp ('Laminaria' spp. and 'Aqarum cribrosum') in St. Margaret's Bay, Nova Scotia is averaged *over* the whole bay and in the kelp zone. This is one of the few studies of kelp productivity from northern areas.

MASON, D. T.. 1980.
Arctic saltmarsh lakes.
pp. 579 - 594 In: NOAA, Office of Marine Pollution Assessment (cd.). Environments] Assessment of the Alaskan Continental Shelf. Annual repts. of principal investigators for the yr. ending Mar 1980. Vol.1: Receptors- Birds, plankton, littoral, benthos. Prepared for BLM. Washington, D.C.

ALASKA: HBAS
Keywords: Macrophytes; Ecology; Waterfowl.

The main foci of this report are chemical limnology and geological structure, however, useful descriptive information on macrophyte communities is provided for an area where very few studies have been performed.

MC BRIDE, D. N., J. H. Clark, & L. S. Bulkis. 1982.
Assessment of intertidal aquatic plant abundance in the Togiak area of Bristol Bay, AK, 1978 through 1980, with emphasis on 'Fucus' sp.
AK Dept. Fish & Game, Div. Comm. Fish. Juneau, AK. Tech . Data Rept. No. 74. 16pp.

ALASKA: SGBA NABA
Keywords: Rockweed; Biomass; Density; Macrophytes .

Average weights of 'Fucus' sp. (the dominant beach cover) kelp ('Laminaria' sp.), and eelgrass ('Zostera' sp.) are reported.

MC ROY, C. P.. 1970.
Standing stocks and other features of eelgrass ('Zostera marina') populations on the coast of Alaska.
J. Fish. Res. Bd. Canada 27 :p.1811 - 1821.

ALASKA: NORB HBAS
Keywords: Macrophytes; Biomass; Calorie Content.

Standing stocks of eelgrass were measured at 10 locations in Alaska , from the southeastern port-ion to the Seward Peninsula. Stocks (biomass) were highest in Kinzarof and Izembek Lagoons. Estimates of the total crops for sampled areas are giver,.

MC ROY, C. P.. 1974.
Seagrass productivity: Carbon uptake experiments in eelgrass 'Zostera marina'.
Aquiculture 4:p.131 - 137.

ALASKA : KODK NABA NORB CKIN
Keywords: Macrophytes; Productivity.

Carbon uptake was measured for eelgrass collected from Izembek Lagoon, AK. The relationship of carbon uptake to light intensity was determined.

MC ROY, C. P., J. J. Goering,
M. T. Gottschalk, M. Mueller, & S. Stoker. 1971.
Survey of macrophyte resources in the coastal waters of Alaska. Report of progress during first year to the Sea Grant Program.
Univ. AK Inst. Marine Science. College, AK.
Rept. No. R71-6. 16pp.

ALASKA : SHUM
Keywords: Macrophytes.

Preliminary report is limited to species lists for stations in southeastern Alaska and one Alaska peninsula station. No later reports from this study have been identified.

MINERALS MANAGEMENT SERVICE. 1983e.
Arctic Sand and Gravel Lease Sale. Final Environmental Impact Statement.
MMS, Alaska OCS Region. Anchorage, AK.

ALASKA : BEAU
Keywords: Finfish; Birds;
Mammals.

Short summaries describe environments and environmental issues in Beaufort Sea; most of these topics are covered more comprehensively in other literature.

MINERALS MANAGEMENT SERVICE. 1984a.
Gulf of Alaska/Cook Inlet Lease Offering. Draft Environmental Impact Statement (October 1984). Text & Graphics 1-6.
MMS, Alaska OCS Region. Anchorage, AK.

ALASKA: GOAK KODK CKIN SHUN
Keywords: Finfish; Birds.; Mammals ; Endangered species.

Clear, color maps show distribution of marine anti coastal birds (graphic 2), marine mammals (graphic 3), and endangered species (graphic 4).

MINERALS MANAGEMENT SERVICE. 1984c.
Proposed Southern California Lease Offering (Feb, 1984). Commercial Fisheries. Graphic No.6.

PACIFIC: SCAL CCAL
Keywords: Maps; Commercial landings; Average catches; Abundance categories; Fisheries production.

Commercial fisheries landings averaged for the years 1970-1974 are summarized in eight abundance categories referenced to 278 km squared blocks.

MOONEY, H. A. & D. J. Parsons. 1973.
Structure and function of the California chaparral - An example from San-Dimas.
pp.83 - 112 In: F. diCastri & H. A. Mooney (cd.).
Mediterranean Type Ecosystems.
Springer-Verlag. New York. 405pp.

PACIFIC: SCAL

This chapter is a process-oriented study and review of a specific site investigated in foothill chaparral vegetation.

MURRAY, L. . 1983.
Metabolic and structural studies of several temperate seagrass communities, with emphasis on microalgal components.
Ph.D. Dissertation. VIMS/ College of William and Mary. Williamsburg, VA. 90pp.

ATLANTIC: MATL
GULF OF MEXICO: CGUL
Keywords: Macrophytes; SAV; Chesapeake Bay; Mudflats; Production.

This dissertation reports on seasonality and partitioning of productivity among subcommunities species submerged aquatic vegetation bed. Information is provided on community structure, epiphytes and faunal associates.

MURRAY, S. N.. 1974.
Benthic algae and grasses. Chapt. 9.
pp. 1 - 61 In: M. D. Dailey, B. Hill, & N. Lansing (cd.).
A summary of knowledge of the Southern California coastal zone anti offshore are as. Vol.II. Biological environment .
Prepared for ELM. Contract No. 08550-CT4-1 .
The So. CA. Ocean Studies Consortium.

PACIFIC: SCAL
Keywords: Macrophytes .

The report focuses upon the taxonomy, ecology, and economic resources of red, green, and brown algae and grasses. Extensive lists of species are provided but quantitative information is limited to kelp. Literature is reviewed from 1905 to 1974.

NATIONAL RESEARCH COUNCIL. 1982.
Impacts of emerging agricultural trends on fish and wildlife habitat.
National Academy Press. Washington, D. C. 303pp.

ATLANTIC: NATL
Keywords: Human impacts; Natural resources; Coastal zone; Estuaries; Beaches.

This book is an innovative and comprehensive attempt to assess impacts of current agricultural practices on various habitats and communities, including coastal and estuarine areas.

NELSON, J. I.. 1981.
Inventory of the natural resources of Great Bay estuarine system. Vol.1.
NH Fish & Game Dept. 254pp.

ATLANTIC: NATL
Keywords: SAV; New Hampshire;
Shellfish beds; Mammals; Birds, invertebrates.

This report is a detailed survey of abundance and distribution of biota of major habitat-s in this large boreal estuary. Interesting for its attempt to fix economic values of biotic components, and valuable for its coverage of non economic species.

NIXON, S. L'.. 1980.
Between coastal marshes and coast-al waters - A review of twenty years of speculation and research on the role of salt marshes in estuarine productivity and water chemistry.
pp.437 - 525 In: P. Hamilton & K. B. MacDona'd (cd.).
Estuarine Wetland Processes.
Plenum Publishing Co. New York.

ATLANTIC: NATL
Keywords: Marshes; Macrophytes;
Marine resources; Ecosystems; Nutrients.

This chapter is an innovative and surprising analysis of the role of salt marsh estuaries in marine coastal resource production. It represents an important conceptual advance.

NIXON, S. W. & C. A. Oviatt. 1973.
Ecology of a New England salt marsh.
Ecol . Monogr. 43 :p.463 - 498.

ATLANTIC: NATL
Keywords: Marsh; Macrophytes;
'Spartina' ; Ecosystems; Estuaries.

NORTH, W. J. . 1971,
The biology of giant kelp beds ('Macro cyst is')
in California.
Nova Hedwegia 32 :p.1 - 97.

PACIFIC: SCAL CCAL

This detailed discussion of community structure is of limited usefulness due to dated methods and analysis.

NOWELT., R. C.. 1976.
Adaptation to Environment: Essays on the Physiology
of Marine Animals.
Butterworths. Boston. 539pp.

PACIFIC: SCAL

This collection provides detailed discussion of specific aspects of adaptation to high salinity environments.

ODUM, E. P.. 1983.
Basic Ecology.
Saunders College Publishing. New York, NY.
613pp.

GULF OF MEXICO: CGUL
PACIFIC: SCAL
Keywords: Outwelling; Salt marshes.

General ecological principles with emphasis on holistic interaction are presented and critical ly discussed. A summary of a large number of published studies in ecology and environmental science is included. Hierarchic organization contains chapters on ecosystems, energetic, biogeochemistry, populations, and ecosystem development. An extensive bibliography, many useful figures, and appendix of ecosystem descriptions including wetlands and aquatic habitats are also included.

ODUM, W. E., C. C. Mc Ivor,
& T. J. Smith, 111. 1982.
The ecology of the mangroves of south Florida:
A community profile.
USFWS, Office of Biological Services. Washington, D.C.
FWS/OBS 81/24. 144pp.

GULF OF MEXICO: EGUL CGUL WGUL
Keywords: Mangrove; Community;
Primary production; Florida.

Mangrove community interactions are described. Production values are presented and are based on previous studies. Factors governing mangrove growth and distribution are discussed.

PAINE R. T.. 1984.
Ecological determinism in the competition
for space.
Ecology 65 :p.1339 - 1348.

PACIFIC: ORWA

A study Of "patches" formed by natural removal of mussels from the very dense intertidal beds on the northern Washington coast is presented.

PAISE, R. T. & R. L. Vodas. 1969.
The effects of grazing by sea urchins, 'Stronglo
centootis' spp.
Limnol. Oceanogr. 14 :p.710 - 719.

PACIFIC: SCAL

This classic study documented the impact of urchin grazing on kelp communities and suggested the importance of urchins in maintaining community diversity.

PAMATMAT, M. . 1968.
Ecology and metabolism of a benthic community of an intertidal sandflat.
Inter. Rev. Der Gesamten Hydrobioloy 53 :p.211 - 298.

GULF OF MEXICO: CGUL
Keywords: Mudflats; Production;
Atlantic coast.

This is an exhaustive study and summary of knowledge of energetic interactions of an intertidal sandflat. It is somewhat dated methodologically , but no such complete study has appeared in the interim.

PEARSE, J. S. & A. H. Hines. 1979.
Expansion of a central California kelp forest following the mass mortality of sea urchins.
Mar. Biol. 51 :p.83 - 91.

PACIFIC: SCAL

This is an experimental study demonstrating the role of urchin grazing in suppressing kelp coverage in lithophytic communities.

PELTO, M. J. & R. E. Peterson. 1984a.
Meteorology, sea conditions and sea ice. Chapt .3
In: L. E. Jarvela (cd.).
The Navarin Basin Environment and Possible Consequences of Planned Offshore Oil and Gas Development.
MMS , Alaska OCS Region. Juneau, AK.

ALASKA : NAVB
Keywords: Oceanography; Pack Ice;
Marginal Ic e Zone.

PENHALE, P. A.. 1977.
Macrophyte - epiphyte biomass and productivity in an eelgrass ('Zest.cra marina' I..) communi Ly.
J. EXP. Mar. Biol. Ecol. 26 :p.211 - 224.

ATLANTIC: SATL
Keywords: Macrophytes; Epiphytes; Production; Eelgrass.

PETERSON, C. H. & N. M. Peterson. 1979.
The ecology of intertidal flats of North Carolina: A community profile.
USFWS, Office of Biological Services. Washington, D.C.
FWS/OBS 79/39. 73pp.

ATLANTIC: MATL SAT L
Keywords: SAV; North Carolina; Salt marsh; Macrophytes; Primary production.

This is a seminal report on ecology of intertidal flats. Good summary of available information and valuable synthesis of data to provide an overall picture of food webs dynamics and whole-systems functioning.

POMEROY, L. R.. 1959.
Algal productivity in Georgia sal t marshes.
Limnol. Oceanogr. 4 :p.386 - 397.

GULF OF MEXICO: WGUL
Keywords: Benthic algae; Georgia; Production; Marshes.

This paper is the first study of the contribution of algae to t.eta] community production ineastcoastsalt marshes. It is dated , but still useful due to paucity of research on this specific factor since its publication.

PULLEN, E. J. & S. M. Nagui. 1983.
Biological impacts of beach replenishment and borrowing.
Shore And Beach 51 ; p.27 - 31.

PACIFIC: SCAL

This short paper is a popular style summary of replenishment impacts. Superficial treatment reduces scientific usefulness, but this subject is rarely addressed in "hard" literature.

RIZZO, W. M. & R. G. Wetzel. 1985.
Intertidal & shoal benthic community metabolism in a temperate estuary.
Estuaries (submitted).

GULF OF MEXICO: CGUL
Keywords: Mudflats; Atlantic coast; Productivity.

Seasonal dynamics and annual production of several shallow estuarine habitats are presented in a comparison study. Data is provided on several habitats which are rarely studied from this perspective (sand flats, mixed mud-and-sand flats, mudflats).

ROSENEAU, D. G. & D. R. Herter. 1984.
Marine and coastal birds. Chapt. 5.
pp.81 - 115 In: J. C. Truett (cd.).
The Barrow Arch Environment and Possible Consequences of Planned Offshore Oil and Gas Development. Proc. of synthesis meeting, Girwood, AK, 30 Ott - 1 Nov 1983.
NOAA/MMS, OCSEAP. Juneau, AK.

ALASKA: CHKS
Keywords: Birds; Distribution; Abundance ; Habitats; Migration, Nesting.

Migratory maps and species accounts for birds in the Chukchi Sea include a discussion of potential effects of petroleum development

RUBER, E., G. Gillis,
& P. A. Montagna. 1981.
Production of dominant emergent vegetation and of
pool algae in a northern Massachusetts salt marsh.
Bull. Of The Torrey Botanical Club 108 :p.108 - 188.

ATLANTIC: NATL
Keywords: Macrophytes; Salt marsh;
Production rates.

SCHAMEL, D. (cd.). 1978.
Birds . Part 5
pp.152 - 167 In: NOAA, Arctic Project Office (cd.).
Environmental Assessment of the Alaskan Continental Shelf.
Interim Synthesis: Beaufort/Chukchi . Prepared for BLM.
Washington, D.C. NOAA, OCSEAP, Environmental Research lab.
Boulder, CO.
Rept. No. NOAA-;78111302. 370pp.

ALASKA: CHKS
Keywords: Birds; Distribution;
Abundance.

Distributional maps and discussions of birds by habitat types on the Beaufort and Chukchi Sea coasts are provided,

SCHEFFER, V. B.. 1972.
Marine mammals in the northwestern Gulf of Alaska.
In: D. H. Rosenberg (cd.).
A Review of the Oceanography & Renewable Resources
of the Gulf of Alaska.
Univ. AK. Fairbanks, AK.

ALASKA: GOAK KODK CKIN SGBA
Keywords: Food; Distribution;
Ecology; Mammals.

This chapter is a useful but somewhat dated review of Alaska marine mammals. It contains harvest statistics & population estimates of marine mammal populations.

SCHELL, D. M. & R. A. Homer. 1981.
Primary production, zooplankton, and trophic dynamics of the Harrison Bay and Sale 71 area. Chapt. 1 . 1. pp.3 - 12 In: D. W. Norton & W. M. Sackinger (cd.). Beaufort Sea (Sale 71) Synthesis Report. Proceedings of a synthesis meeting, Chena Hot Springs, AK. April 21-23, 1981.
NOAA/BLM, OCSEAP. Juneau, AK.

ALASKA : BEAU
Keywords: Phytoplankton; Zooplankton;
Carbon 14 production; Ice algae; Carbon input budget.

This report is of particular interest because of the discussion of terrestrial carbon sources in the Arctic mat-shore environment.

SCHMIDLY, D. J.. 1981.
Marine mammals of the southeastern United States coast and the Gulf of Mexico.
USFWS , Office of Biological Services. Washington, D.C.
FWS/OBS 80/41.

GULF OF MEXICO: EGUL
Keywords: Mammals; Distribution;
Endangered species; Cetaceans; Manatee.

This report provides a detailed species - by - species account of abundance and distribution of marine mammals of the south Atlantic anti Gulf coasts of the United Stat es. Useful summaries are provided of ecology and feeding habitats based on published information.

SCIENCE APPLICATIONS, INC.. 1979.
Boulder, CO.
Environmental Assessment of the Alaskan Continental Shelf: Lower Cook Inlet interim synthesis report, July 1979.
Prepared for NOAA. Boulder, CO.

ALASKA : CKIN
Keywords: Mammals; Birds;
Finfish; Benthos.

A valuab: e summary of data, w th emphasis on fi sh and benthos. Includes an excellent section on distribution, biomass and product. vity of macroalgae in the Kodiak region.

SCIENCE APPLICATIONS, INC.. 1980a.
Boulder, CO..
Environmental assessment of the Alaskan continental shelf: Kodiak Interim Synthesis Repot-t.
Prepared for NOAA, OCSEAP.

ALASKA : KODK
Keywords: Birds; Finfish;
Benthos; Macroalgae.

A valuable summary of data, with emphasis on fish and benthos is contained in this chapter. Included is an excellent section on distribution, biomass, and productivity of macroalgae in the Kodiak region.

SEAMAN, G. A., G. F. Tandy, T). T... Clausen, D. L. Clausen, & L. L. Trasky. 1981.
Mid-Beaufort coastal habitat evaluation study: Colville Rivet- to Kuparuk River. Report for North Slope Borough. (Revisions included, March 1982.).
AK Dept. Fish & Game, Habitat Div. Anchorage, AK.
206pp.

ALASKA : BEAU
Keywords: Finfish; Birds;
Mammals; Inland Biology.

Habitat descriptions and species life histories for coastal, marine and inland fish, birds and mammals include a section dealing with management recommendations and information gaps.

SEARS, H. S. & S. T. Zimmerman. 1977.
Alaska Intertidal Survey Atlas.
NOAA, NMFS. Auke Bay, AK. 449pp.

ALASKA : GOAK KODK CKIN SHUM
NABA SGBA SMHL NORB
Keywords: Beach Substrate; Topography;
Macrophytes; Birds; Mammals.

Aerial survey of Alaska coastline from Yakutat to Cape Prince of Wales (Bering Strait) recorded beach substrate, biological cover, slope, and observations of macrophyte, bird, and mammals on small-scale (~ 1:100,000) maps.

SHEW, D. M. , R. H. Bauman,
et al. . 1981b.
Texas barrier islands region ecological
characterization: Environmental synthesis papers.
USFWS , National Coastal Ecosystem Team. Slidell, LA.
FWS/OBS 82/32.

GULF OF MEXICO: WGUL
Keywords: SAV; Barrier Islands;
Mangrove ; Species lists; Salt Marsh.

SIMPSON, R. L, R. E. Good,
M. A. Leek, & J). F. Whigham. 1983.
The ecology of freshwater tidal wetlands.
Bioscience 33 :p.255 - 259.

ATLANTIC: MATL
Keywords: Freshwater Wetlands; New Jersey;
Primary production; Intertidal; Macrophytes.

A somewhat- nontechnical summary of tidal freshwater ecosystems.
Valuable for conceptual outline of systems-level processes.
Bibliography is sketchy.

SMITH, K. K., R. E. Good,
& N. F. Good. 1979.
Production dynamics for above and belowground
components of a New Jersey 'Spartina alterniflora' tidal
marsh .
Est. Cstl. Mar. Sci. 9 :p.189 - 201.

ATLANTIC: MATL
Keywords : Salt marsh production; Manahawkin marshes.

SOUTH ATLANTIC FISHERY MANAGEMENT
COUNCIL. Charleston, SC. 1983b.
Source document for the snapper-grouper fishery of
the south Atlantic Region.
292pp.

ATLANTIC: SATL
Keywords: Commercial statistics; Population dynamics;
Reef fish; Life history; Stock assessment.

This source document is the background material for the Snapper-Grouper Fishery Management Plan of the South Atlantic Region containing detailed supportive documentation on which the management regime for the snapper-grouper fishery is based.

SOWLS, A. I.., S. A. Hatch,
& C. J. Lensink. 1978.
Catalog of Alaskan seabird colonies.
BLM/ USFWS, Office of Biological Services. Washington, D.C.
FWS/OBS 78/78. 29pp., 153 maps, + appendices.

ALASKA : GOAK KODK CKIN SHUM
NABA SGBA S,MlII, NORB
HBAS CHKS BEAU
Keywords: Seabirds; Distribution;
Abundance .

Quadrangle maps for the entire Alaskan coast show locations of seabird colonies. Accompanying tables give species and numbers present for each colony. A short descriptive text is furnished for each map.

SPRINGER, A. M. & J. G. Strauch, Jr.. 1984.
Marine birds. Chapt. 7.
In: L. E. Jarvela (ed.).
The Navarin Basin Environment and Possible Consequences of
Planned Offshore Oil and Gas Development.
MMS/Alaska OCS. Juneau, AK.

ALASKA: NAVB
Keywords: Marine Birds; Distribution;
Abundance; Trophies.

STEELE, J. H. & 1. E. Baird. 1968.
Production ecology of a sandy beach.
Limnol. Oceanog. 13 :p.14 - 25.

GULF OF MEXICO: CGUL
Keywords; Beaches; Production.

This paper provides some of the few data available on energetic interactions in a sandy beat]] environment.

STEPHENSON, T. A. & .4. Stephenson. 1972.
Life between Tidemarks of Rocky Shores.
w. H. Freeman & Co. San Francisco, CA. 425pp.

PACIFIC: SCAL
Keywords: Intertidal.

Flora and fauna between tidelines on rocky shores are compared among coasts throughout the world. Descriptions for Pacific Grove and La Jolla, CA are used as examples.

STOUT, J. P. & A. A. De La CL-LIZ. 1981.
Marshes of Mississippi Sound: State of the knowledge.
pp.8 - 20 In: J. R. Kelly (ed.).
Symposium on Mississippi Sound.
MS - AL Sea Grant Consortium.
N OAA #NA-81-AA-D-00050. 152pp.

GULF OF MEXICO: CGUL
Keywords: Salt Marsh Production; MS - AL Coast; Marsh Distribution; Macrophytes; Biomass.

This is a short but valuable summary of production, standing stock anti distribution of marshes of the Mississippi Sound region.

STOUT, J. P. & M. J. Lelong. 1981 .
Wetland habitats of the Alabama coastal area.
AL Coastal Area Board. Tech. Publ. CAB-81-01.

GULF OF MEXICO: EGUL
Keywords: Salt marshes.

SUGIHARA, T., C. Yearsley,
J. B. Durand, & N. P. Psuty. 1979.
Comparison of natural and altered estuarine systems:
Analysis.
Rutgers Univ. Center for Coastal and Environmental Studies.
New Brunswick, NJ.
CCES Publ. No. NJ/ RU-DEP-11-9-79. 247pp.

ATLANTIC : MATL
Keywords: Macrophyte Production; Manahawkin marshes;
Food Chain Dynamics; Wildlife; Phytoplankton.

Outstanding comparison of biotic functioning in a highly disturbed and a relatively undisturbed salt marsh estuary. Particularly useful for its concentration on systems level interactions and quantitative information on higher trophic levels.

TEAL, J. M.. 1980
Primary production of benthic and fringing plant communities.
pp.67 - 83 In: R. S. K. Barnes & K. H. Mann (ed.).
Fundamentals of Aquatic Ecosystems.
Blackwell Scientific Publ. Oxford, England.

GULF OF MEXICO: CGUL
PACIFIC: SCAL
Keywords: Macrophytes; Freshwater wetlands;
Production; Marsh; Habitats.

This chapter is a concise and valuable review of environmental factors affecting primary production in shallow aquatic habitats. Conceptually useful, it presents little hard data.

TOP INKA, J. , L. Tucker ,
& W. Korjeff. 1981.
The distribution of fucoid macroalgae biomass along central coastal Maine.
Botanica Marina 24 :p.311 - 319.

ATLANTIC: NATL
Keywords: Algae; Macrophytes; Productivity; Intertidal.

This paper presents results of field studies of distribution and abundance of fucoid algae on rocky coasts of central Maine. Data are presented on biomass and density, and assumptions are used to derive productivity estimates.

TRUETT, J. C. (ed.). 1984b.
The Barrow Arch environment and possible consequences of planned offshore oil and gas development.
Proceedings of a synthesis meeting.
NOAA/MMS, OCSEAP.

ALASKA: CHKS

TURNER, R. F.. 1976.
Geographic variations in salt marsh macrophyte production: A review.
Mat-. Sci . 20 :p.47 - 68.

ATLANTIC: MATL SATL
Keywords: Macrophytes Salt Marsh; Abov eground production; Review.

This review assesses atitudinal gradients in productivity and energy conversion efficiency of salt marsh macrophytes. Methodology is discussed from the perspective of unmeasured biomass turnover and subsequent underestimates of salt marsh productivity.

TURNER, R. E. & J. G. Gosselink. 1975.
A note on standing crops of 'Spartina alterniflora'
in Florida and Texas.
Contr. Mar. Sci., Univ. Tex. 19 :p.113 - 118.

GULF OF MEXICO: WGUL
Keywords: Salt marsh; Production;
Macrophyte ; 'Spartina alterniflora' .

This paper is a short comparison of data on standing stock of the salt marsh dominant 'S. alterniflora' in the subtropics of the Gulf of Mexico.

TURNER, T.. 1985.
Stability of rocky intertidal surfgrass beds:
Persistence, preemption, and recovery.
Ecology 66 :p.83 - 92.

PACIFIC: ORWA
Keywords: Macrophytes; Distribution;
Abundance.

Surfgrass was dominant component of intertidal cover at two sites in Oregon. Recovery from artificial disturbance was slow.

VALIELA, I., J. M. Teal,
S. Volkmann, D. Shafer, & E. J. Carpenter. 1978.
Nutrient fluxes in a salt marsh ecosystem:
Tidal exchanges and inputs by precipitation
and groundwater.
Limnol. Oceanogr. 23 :p.798 - 812.

ATLANTIC: NATL
Keywords: Macrophyte; Salt marsh;
Nutrient flux; Estuary.

This paper is a detailed analysis of partitioned input of water and nutrients to a tidal salt marsh.

VASSALLO, M. T.. 1969.
The ecology of 'Macoma inconspi cua' (Broderip and Sowerby, 1829) in central San Francisco Bay. Part I. The vertical distribution of the 'Macoma' communi ty.
Veliger 11 :p.223 - 234.

PACIFIC: CCAL

VIRNSTEIN, R. W.. 1982.
Leaf growth rate of the seagrass 'Halodule wrightii' photographically in situ.
Aquat. Bot. 12 :p.209 - 218.

ATLANTIC: SATL
Keywords: Macrophytes ; 'Halodule wrightii' ; SAV; Turnover rates.

An innovative technique of clipping and time-successive photography was used to assess growth rate of the seagrass 'Halodule wrightii'.

WAALAND, J. R..]977.
Growth of Pacific Northwest marine algae in semi-enclosed culture. Chapt. 7.
pp.117 - 137 In: R. W. Krauss (cd.).
The Marine Plant Biomass of the Northwest Coast.
Oregon State Univ. Press. 397pp.

PACIFIC: ORWA
Keywords : Macroalgae; Productivity.

An experimental study of biomass production by macroalgae in natural waters is reported.

WESTLAKE, D. F.. 1963.
Comparisons Of plantproductivity.
Bio. Rev. 38 :p.385 - 425.

ATLANTIC; NATL
Keywords: Macrophyte; Productivity.

This paper is a dated, but still thorough and useful, Comparative review of plant productivity.

WHIGHAM, f). F. , J. McCormick,
R. E. Good, & R. L. Simpson. 1978.
Biomass and primary production in freshwater
tidal wetland of the middle Atlantic coast.
pp.3 - 20 In: R. E. Good, D. F. Whigham,,
& R. L. Simpson (eds.).
Freshwater wetlands: Ecological processes and
management potential.
Academic Press. New York.

ATLANTIC: MATL

WICKER, K. M.. 1980.
Mississippi deltaic plain region ecological
characterization: A habitat mapping study. A user's guide
to the habitat maps. May, 1980.
USFWS, Office of Biological Services. Washington, D.C.
FWS/OBS - 79/07.

GULF OF MEXICO: CGUL
Keywords: Beaches; Salt marshes;
Mangroves; Habitats; Freshwater wetlands.

The text of this user's guide provides valuable information
about a variety of coastal habitats in the Mississippi delta.
It is particularly useful for attempts at systems-level synthesis
and delineation of controlling environmental parameters.

WILLIAMS, S. L. & C. P. Mc Roy. 1982.
Seagrass productivity: The effect of light on
carbon uptake.
Aquat. Bot. 12 :p.321 - 344.

ALASKA : KODK
PACIFIC: ORWA
Keywords: Seagrass; Production;
Macrophytes.

Carbon 14 uptake measurements for several macrophyte species under
varied light levels is presented. 'I'his is the only reference for
the presence and distribution of surfgrass ('Phyllospadix
scouleri') in Alaskan coastal environments.

WILSON, K. C., P. L. Haaker,
& D. A. Hanan. 1977.
Kelp restoration in Southern California.
pp. 183 - 202 In: R. W. Krauss (cd.).
The Marine Plant Biomass of the Pacific Northwest Coast.
Oregon State Univ. Press. Corvallis, OR.

PACIFIC: SCAL
Keywords: Macrophytes ; Sewage impacts.

Case studies are presented to indicate that kelp beds can be rapidly restored after perturbation, e.g. sewage, is removed or reduced.

WINZLER & KELLY CONSULTING ENG.
Eureka, CA. 1977.
A summary of knowledge of the central and northern coastal zone and offshore. Prepared for BLM.
Washington, D. C. Contract AA550-CT6-52.
Rept. No. BLM-ST-78-19.

PACIFIC: NCAL
Keywords: Endangered species; Seabirds, occurrence;
Seabirds, abundance .

The abundance and occurrence of seabirds and endangered species north of Pt. Conception to the Oregon border are reported. All references cited in individual chapters as well as uncited but pertinent references for specific subjects are listed in the bibliography. Sources date from 1851.

WOODWARD-CLYDE CONSULTANTS. 1982a.
Central and northern California coastal marine habitats: Oil residence and biological sensitivity indices. Final Report. Prepared for MMS, Pacific OCS.
Los Angeles, CA.
POCS Technical Paper No. 83-5. 226pp.

PACIFIC: SCAL CCAL NCAL

Differences between oil residence and biological sensitivity are analyzed. The coastal mainland is divided into outer coastal zone, inner coastal zone, and inlet zone , and shore-zone components (e.g. sand , rock, boulder veneer) are discussed for each zone.

WOODWARD-CLYDE CONSULTANTS . 1982b.
Central and northern California coastal marine habitats: Oil residence and biological sensitivity indices. Executive Summary. Prepared for MMS, Pacific OCS. Los Angeles, CA.
POCS Technical Paper No. 83-6. 34pp.

PACIFIC: SCAL CCAL NCAL

Besides summarizing the main points of the full study, the executive summary provides a glossary of substrata (e.g. boulder veneer, sand, and rock) and a key to symbols used on accompanying maps which were generated during the study.

WOODWELL, G. M., D. E. Whitney,
C. A. S. Hall, & R. A. Houghton. 1977.
The Flax Pond ecosystem study: Exchange of carbon in water between a salt marsh and Long Island Sound.
Limnol. Oceanogr. 22 :p.833 - 838.

ATLANTIC: NATL
Keywords : Coastal marshes.

Excellent study of nutrient flux between a marsh and its open-water estuary. However , the aberrant physical characteristics of Flax Pond reduce the generality of conclusions.

ZEDLER, J. B.. 1984.
Salt marsh restoration. A guidebook for southern California.
CA Sea Grant College Program, Univ. CA Inst. Marine Resources. La Jolla, CA. Rept. No. T-CSGCP-009 . 46pp.

PACIFIC: CCAL
Keywords: Salt marsh.

ZEDLER, J. B., T. Winfield,
& P. Williams. 1980.
Salt marsh productivity with natural and altered
tidal circulation.
Oecologia 44 :p.236 - 240.

PACIFIC: SCAL

Experimental study of productivity and impoundment impacts on
southern California salt marshes is a rare contribution to
knowledge of this under-studied habitat.

ZIEMAN, J. C.. 1982.
The ecology of the seagrasses of south Florida:
A community profile.
USFWS, Office of Biological Services. Washington, D.C.
FWS/OBS-82/25. 158pp.

ATLANTIC: SATL
GULF OF MEXICO: EGUL
Keywords: Macrophytes; Review;
Production; Distribution; SAV.
SAV.

A community profile is presented for a south Florida seagrass bed.
Plant distributions and production values are given. Included is
a detailed description of trophic interactions in a seagrass bed
and environmental factors governing the growth and distribution
of seagrassses.

ZIMMERMAN> S. T. (ed.). 1982.
The Norton Sound environment and possible consequences of planned offshore oil and gas development.
Proceedings of a synthesis meeting, Anchorage, AK.
October 28-30, 1980.
NOAA/BLM OCSEAP. Juneau, AK. 55pp.

ALASKA: NORB SMHL
Keywords: Mammals; Shellfish;
Benthos; Birds.
Bottomfish Resources; Ocean circulation;
Oil spill impacts; NE Bering Sea,

The emphasis of this report is on impacts, however much useful information on fish, bird, and mammal distributions and coastal habitats is included. Some of material r.descriptive of coastal habitats is not to be found elsewhere.

ZIMMERMAN, S. T., J. L. Hanson,
J. T. Fujiake, et al.. 1979.
Intertidal biota and subtidal kelp communities of the Kodiak Island area..
pp.316 - 508 In: NOAA, OCSEAP (cd.).
Environmental Assessment of the Alaskan Continental Shelf,
Biological Studies. Vol. 4. Prepared for BLM.

ALASKA : KODK SGBA
Keywords: Kelp, biomass; Kelp, standing stock.

The extent of tile beds, biomass, and floating standing stock of kelp in the Kodiak Island area were measured. Biomass measurements were wet weight.