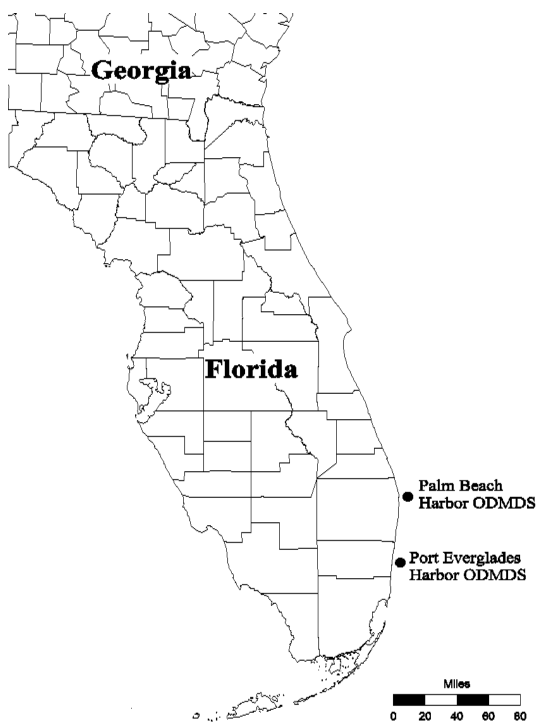
904/9-04-003

Section 3

Final Environmental Impact Statement (FEIS) for Designation of the Palm Beach Harbor Ocean Dredged Material Disposal Site and the Port Everglades Harbor Ocean Dredged Material Disposal Site

July 2004



United States Environmental Protection Agency

U.S. EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303

- Designation of the 4.5-mile site would require significantly less consumption of resources (e.g., fuel, federal dollars) than the 9-mile site for transportation of dredged material for disposal.
- Designation of the 4.5-mile site would result in significantly less air emissions from the disposal vessel than the 9-mile site.
- Monitoring of the 4.5-mile site would be less costly and less difficult than monitoring the 9-mile site due to the 9-mile site's greater depths and distance from shore.

2.6.2 Port Everglades Harbor Preferred Alternative

Based on comparison of the alternative sites to the general and specific criteria, the 4-mile site was selected by EPA and the USACE as the preferred alternative. This site was selected for the following reasons:

- Sediment surveys of the site indicate that sediments within the 4-mile site are similar to the dredged material proposed for disposal. Sediments in the northern portion of the 7-mile site are also sandy and similar to proposed dredged material. However, the southern portion of the 7-mile site consists of low relief limestone hard bottom. Disposal of dredged material in this area would result in a significant change in the benthic characteristics.
- No significant impacts to resources or amenity areas (e.g., offshore coral reefs) are expected to result from designation of either the 4-mile or 7-mile site.
- Potential impacts to surface and mid-water dwelling organisms are expected to be insignificant regardless of which of the alternative sites is used for dredged material disposal.
- Potential impacts to bottom-dwelling organisms are considered significant at either of the considered alternative sites. However, the area of impact is expected to be greater at the 7-mile site due to the greater footprint of disposed dredged material at this site. The 7-mile site would require a four-square nautical mile site to contain the footprint of the disposal mound within the site boundaries compared to a one square nautical mile site for the 4-mile site. In addition, disposal of dredged material on the low relief limestone hard bottom within the southern half of the 7-mile site would likely result in a change from a hard bottom to a soft bottom benthos.
- Designation of the 4-mile site would require significantly less consumption of resources (e.g., fuel, federal dollars) than the 7-mile site for transportation of dredged material for disposal.
- Designation of the 4-mile site would result in significantly less air emissions from the disposal vessel than the 7-mile site.
- Monitoring of the 4-mile site would be less costly and less difficult than monitoring the 7-mile site due to the 7-mile site's greater depths and distance from shore.

3.0 AFFECTED ENVIRONMENT

3.1 General Environmental Setting

This section contains a description of the existing environment that may be affected by the disposal of dredged materials at the proposed ODMDSs. This information serves as a basis for projecting environmental impacts that could result from the disposal of dredged material in these regions of the Atlantic Ocean. The information presented in this section was synthesized from both literature and field evaluations.

Site location maps for the Palm Beach Harbor and the Port Everglades Harbor preferred sites are presented in figures 1 and 2, respectively. The alternative sites are located on the Florida-Hatteras Slope off the East Florida Escarpment. East of the Florida-Hatteras Slope lies the Florida Channel, a narrow natural channel running between the slope and the Bahama Banks.

Significant river systems are not abundant in southeastern Florida, and thus riverine runoff does not heavily influence the coastal waters in which the sites are located. The movement of ocean currents such as the Gulf Stream serves as a primary influence on water characteristics in the area.

3.2 Geological Characteristics

3.2.1 Geologic History

The Florida peninsula is the exposed portion of a wide, relatively flat geological feature known as the Florida Platform, which separates the deep waters of the Gulf of Mexico from those of the Atlantic Ocean (Florida Geological Survey, 1994). During the Paleogene Subperiod (66-24 million years ago [Ma]), the Florida Platform was very similar to the modern Bahama Banks, and consisted of a broad area over which carbonate sediments were deposited. The carbonate sediments were deposited by biological processes and consisted largely of the fossil remains of marine organisms. Very little siliciclastic material (sand, silt, and clay) was deposited on the Platform due to the scouring action of a marine current similar to the modern Gulf Stream. In the late Paleocene the renewed uplift of the Appalachian Mountains produced large volumes of siliciclastic sediments that inundated the Platform and encroached upon the carbonate-depositing environments. Siliciclastic deposition became dominant in the Neogene Subperiod (24-2 Ma), with carbonate deposition occurring only as thin beds and lenses within siliclastic deposits. Phosphate deposition also began at this time, in response to upwelling phosphorus-rich water from deep ocean basins. Ice ages in the Quaternary Period (2-0 Ma) exposed large areas of the Platform and allowed the erosion and dissolution of carbonate deposits, resulting in the ubiquitous karst topography found throughout Florida. The subsequent sea level rise following glaciation intervals submerged much of the Platform again. Siliciclastic and carbonate deposition continue to occur in modern times, although the action of the Gulf Stream serves to restrict the amount of sediment deposited.

3.2.2 Physiography

The Florida Platform has an arbitrary termination that coincides with the 300-ft bathymetric contour of the surrounding waters. The Platform extends approximately 100 miles offshore in the Gulf of Mexico, but extends only three to four miles offshore from Palm Beach Harbor to Miami. Water depths increase rapidly within relatively short distances from the edge of the Platform, creating what is known as the Florida Escarpment. The Florida Escarpment is divided into segments according to geographic location; the East Florida Escarpment is the segment located near the project sites. The continental shelf in the vicinity of the East Florida Escarpment is very narrow relative to more northern portions of the Atlantic coastline. Shelf width in the vicinity of the project areas is less than 1.25 miles off the coast, compared with a shelf width of 75 miles off the coast of Georgia (Uchupi, 1968, Murray, 1961). Near Miami, the East Florida Escarpment terminates in a shelf-like platform known as the Miami Terrace. This terrace extends from latitude 26°30’ to latitude 25°20’ and has a maximum width of 22 km. The depth of the terrace ranges from 245-350 m (804-1148 ft) (Uchupi, 1968). The Miami Terrace appears to represent a relict carbonate platform.

The alternative ODMDSs for both areas are situated on the Florida-Hatteras Slope, which lies immediately east of the East Florida Escarpment. The continental shelf width near the proposed Palm Beach Harbor ODMDSs is 1.17 km (0.73 miles); shelf width near the proposed Port Everglades Harbor ODMDSs is approximately 1.16 km (0.73 miles) (Uchupi, 1968). The Florida-Hatteras Slope has a declivity in the Georgia-Florida region of approximately 1° to depths of 300-500 fathoms (1,800-3,000 ft).

3.2.3 Palm Beach Harbor

4.5-Mile Site (Preferred Site)

The preferred site for the proposed Palm Beach Harbor ODMDS is situated on the Florida-Hatteras Slope. Depths at the proposed site range from about 509 ft (155 m) to 607 ft (185 m). The depth at the center of the proposed site is approximately 558 ft (170 m). A bathymetric map of the vicinity of the proposed ODMDS is presented as Figure 3.

Siliciclastic sediments dominate the area. A January 1989 survey report indicates that surficial sediments in the proposed ODMDS area are comprised primarily of fine-to-very-fine sand sediment texture. Sediment samples from sample stations to the northwest and south-southwest of the proposed site are largely medium-to-fine sand and finer sediments (less than 25% silt), respectively.

A sidescan sonar survey (Appendix E) conducted at the alternative ODMDSs by EPA in August 1998 revealed a relatively uniform fine sandy bottom throughout the site and in areas two miles north and south of the 4.5-mile site. Mean grain size for samples taken at the site ranged from 0.14-0.17 mm, with silts and clays comprising approximately 25-35% of total sediments. No areas of hard bottom or potential wrecks were identified through the sidescan record within the site or in the two-mile areas north and south of the site.

9-Mile Candidate Site

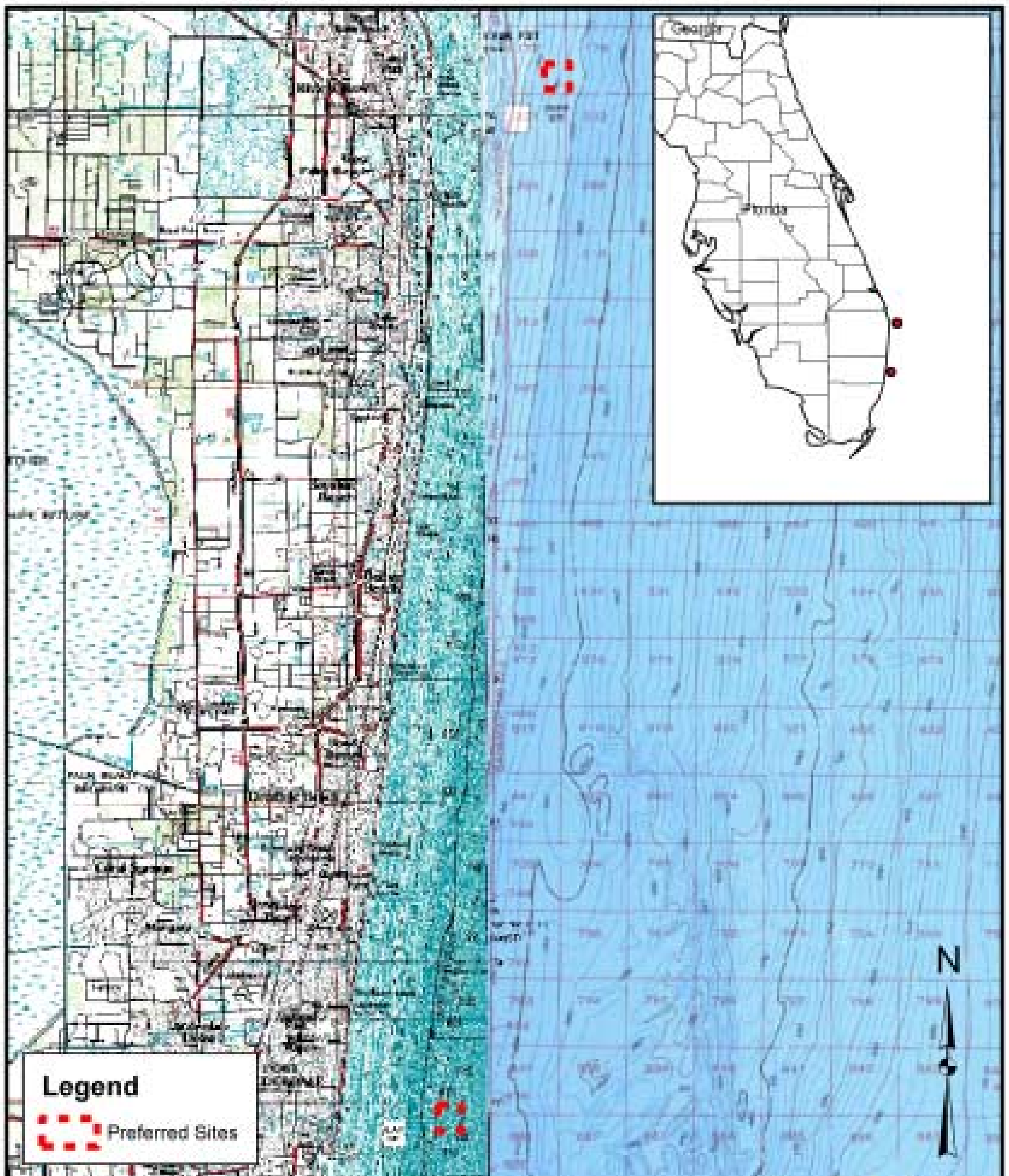
The 9-mile site is also situated on the Florida-Hatteras Slope. Depths at this site range from 855 ft (260 m) to 985 ft (300 m). Bathymetric data for this site can be found in Figure 1.

Sidescan sonar data from the 1998 EPA survey indicated that the seafloor at the site consists of relatively uniform fine sandy bottom. Mean grain size was 0.21 mm, with silts and clays accounting for 18-23% of total sediments. A few scattered acoustical targets were detected within the site boundaries. These sites are not believed to represent any significant resources.

3.2.4 Port Everglades Harbor

4-Mile Site (Preferred Site)

The preferred site for the proposed Port Everglades Harbor ODMDS is also situated on the Florida-Hatteras Slope. Based on studies conducted in the area, depths at the proposed site range from approximately 640 ft (195 m) to 705 ft (215 m). The depth at the center of the proposed site is approximately 656 ft (200 m). Bathymetric data for this site is presented in Figure 3.



PROJECT AREA BATHYMETRY
Palm Beach/ Port Everglades FEIS
Palm Beach and Broward Counties, Florida
USGS 1:250,000 Series West Palm Beach (1987) Quadrangle
and NOAA Bahamas (1988) Bathymetric Map

GEC Gulf Engineers & Consultants
Figure: 3
Date: February 2004
Scale: 1:370,000
Source: USGS/GEC/NOAA

Video/sidescan sonar surveys conducted in March and October 1986 found surficial sediments in the proposed ODMDS area to be comprised primarily of fine-to-coarse grained sand substrate with small isolated patches of cobbles or coralline rubble scattered over the site.

The August 1998 EPA sidescan sonar survey of the proposed ODMDS site indicated a relatively uniform sandy bottom with an east-west oriented low relief ridge in the center of the site and an east-west oriented low relief ridge to the northwest of the site. Samples exhibited a mean grain size of approximately 0.18 mm with silts and clays comprising 16% of total sediments. A number of scattered acoustic targets of varying size were observed in the survey area. Three small targets were located within the site boundaries and one small target was located immediately adjacent to the site. Outside of the site, one acoustical target appears to represent craters or freshwater vents and five acoustical targets were identified as possible wrecks. None of these targets, however, is found within or immediately adjacent to the proposed site.

7-Mile Candidate Site

The 7-mile site is located on the Florida-Hatteras Slope. Depths at the site range from 785 ft (240 m) to 920 ft (280 m).

The August 1998 EPA sidescan sonar survey of the site indicated a transition from a relatively uniform sandy bottom in the north to a relatively uniform low relief hard bottom in the south. Rock samples taken from the site consisted of slightly dolomitic fossiliferous limestone with magnesite dendrites. Mean grain size in the northern portion of the site was approximately 0.22 mm with silts and clays comprising 10-18 % of total sediments. A few scattered acoustical targets were detected during the survey. These targets, which were not identified, appeared on the receiving equipment as dark acoustic signals with shadows.

3.3 Threatened or Endangered Species

Several threatened and endangered species could pass through the vicinity of the alternative ODMDSs. Marine species classified by the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the Florida Fish and Wildlife Conservation Commission (FFWCC) as endangered or threatened in shore or coastal waters off Palm Beach Harbor and Port Everglades Harbor are listed in Table 3. Marine species classified as candidate species by NMFS are listed in Table 4. Candidate species are not protected under the Endangered Species Act, but concerns about their status indicate that they warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.

Blue whales (*Balaenoptera musculus*) are found in all oceans of the world, inhabiting waters ranging from tropical to polar. The species feeds primarily on krill. Most populations of blue whales are migratory. Populations typically spend winter in low latitude waters, migrate toward the poles in spring, feed in high latitude waters during summer, and migrate back toward low latitude waters in fall. Blue whales inhabit open ocean waters.

Table 3. List of Threatened or Endangered Species that Might be Found in the Vicinity of the Alternative Palm Beach Harbor and Port Everglades Harbor ODMDSs

Common Name	**Scientific Name**	**Status**
Mammals		
Blue whale	*Balaenoptera musculus*	Endangered
Finback whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Meqaptera novaeangliae*	Endangered
Right whale	*Eubalaena glacialis*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Sperm whale	*Physeter catodon*	Endangered
West Indian Manatee	*Trichechus manatus*	Endangered
Reptiles		
Green sea turtle	*Chelonia mydas*	Endangered(1)
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Kemp's Ridley sea turtle	*Lepidochelys kempi*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Fish		
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Smalltooth sawfish	*Pristis pectinata*	Endangered
Seagrasses		
Johnson's seagrass	*Halophilia johnsonii*	Threatened

Notes: (1) Green sea turtles are listed as threatened, except for breeding populations of green sea turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

Source: USFWS, FGFWFC, 1997; NMFS, 2002.

Table 4. List of Candidate Species that Might be Found in the Vicinity of the Alternative Palm Beach Harbor and Port Everglades Harbor ODMDSs

Common Name	Scientific Name	Status
Fish		
Dusky shark	*Carcharhinus obscurus*	Candidate
Sand tiger shark	*Odontaspis taurus*	Candidate
Night shark	*Carcharhinus signatus*	Candidate
Speckled hind	*Epinephelus drummondhayi*	Candidate
Atlantic sturgeon	*Acipenser oxyrhinchus oxyrhinchus*	Candidate
Mangrove rivulus	*Rivulus marmoratus*	Candidate
Opossum pipefish	*Microphis brachyurus lineatus*	Candidate
Key silverside	*Menidia conchorum*	Candidate
Goliath grouper	*Epinephelus itajara*	Candidate
Warsaw grouper	*Epinephelus nigritus*	Candidate
Nassau grouper	*Epinephelus striatus*	Candidate

Source: NMFS, 2002.

Finback whales (*Balaenoptera physalus*) also have a cosmopolitan distribution, occurring in all of the world oceans. The species feeds primarily on krill and small schooling fish. Aerial surveys conducted for USFWS in 1980-1981 failed to detect the presence of this species (Fritts *et al*., 1983). Darnell *et al*. (1983) illustrate finback whale habitat as waters at the continental slope and deeper, possibly accounting for the recorded absence of this species during the survey.

Humpback whales (*Megaptera novaeangliae*) are a coastal species that feed primarily on krill and fish. Humpbacks have cosmopolitan distributions and exhibit distinct seasonal migratory patterns. This species can be found in the northernmost reaches of the Atlantic Ocean from spring through early fall. In early fall, they migrate to the Caribbean for calving and breeding. Humpbacks have been sighted in deep water off southeast Florida (Schmidly, 1981).

Right whales (*Eubalaena glacialis*) are the most endangered cetacean species in the western Atlantic. The population size in the Atlantic is currently unknown. Right whales are specialized "skimmers" that feed primarily by swimming slowly through dense concentrations of copepods with their mouths open. They typically feed at or just below the water surface. These whales commonly pass along the coast from North Carolina to Florida during their winter and spring migrations (Schmidly, 1981). The study area is located south of right whale critical habitat.

Sei whales (*Balaenoptera borealis*) usually travel in groups of two to five individuals, feeding primarily on copepods, krill, and small schooling fish (Schmidly, 1981). The migratory patterns of this species are poorly known. Apparently, sei whales are present off the coast of New England during winter. However, the distribution pattern of this species in the western North Atlantic during other times of the year is unknown (Schmidly, 1981). These large cetaceans generally inhabit the continental slope and deep oceanic waters; however, they are occasionally sighted near shore (Schmidly, 1981).

The West Indian manatee (*Trichechus manatus*) inhabits primarily inshore waters of southeastern Florida throughout the year (Provancha and Provancha, 1988). Manatees tend to concentrate in areas at least 2 m deep with submerged aquatic vegetation (Zieman, 1982) and an availability of warm water during winter cold snaps.

Although marine turtles occasionally enter estuaries, they generally prefer higher salinity waters. Nesting may occur throughout the most of their range, but most nesting occurs on restricted areas of beach that turtles return to each nesting season. Foraging areas are often distant from nesting beaches and in order to nest, turtles may migrate long distances. Mating generally takes place in offshore waters near the nesting beach and males rarely come ashore (Fuller, 1978).

Green sea turtles (*Chelonia mydas*) are most abundant between 35° N latitude and 35° S latitude, particularly in the Caribbean. The green sea turtle usually frequents shallow reefs, shoals, lagoons, and bays where marine grasses and algae are plentiful. Its preferred nesting sites are steep, sloped beaches, well above high tide, in the Yucatan Peninsula, Caribbean, and Florida (Minerals Management Service [MMS], 1989).

The loggerhead sea turtle (*Caretta caretta*) occurs throughout the warm and temperate oceanic waters worldwide. The species has been observed as far as 500 miles offshore. Loggerheads frequent natural and manmade structures, including oil and gas platforms, where they forage on benthic invertebrates, fish, and aquatic vegetation. About 90% of the total nesting in the United States occurs on the south Atlantic coast of Florida (Fritts *et al*., 1983). Loggerhead densities seem to be highest during summer months (Fritts *et al*., 1983).

The leatherback sea turtle (*Dermochelys coriacea*) has a pantropical distribution and is probably are the most oceanic of all sea turtles, preferring deep waters (Rebel, 1974). Leatherback sea turtles migrate widely and have been reported as far north as Nova Scotia (Lazell, 1980). Major rookeries are rare for this species and dispersed nesting is common.

Hawksbill sea turtles (*Eretmochelys imbricata*) inhabit reefs and shallow coastal areas and passes in water less than 15 m deep, where they feed on benthic invertebrates and vegetation (Fuller *et al*., 1987). The hawksbill is a solitary nester between 25° N latitude and 25° S latitude, including the southeast coast of Florida.

The Kemp's Ridley sea turtle (*Lepidochelys kempi*), while having a pantropical distribution, is probably the most endangered of the sea turtles. Ridley sea turtles commonly inhabit shallow coastal and estuarine waters. Their nesting is restricted to a small stretch of beach near Rancho Nuevo, Ramaulipas, Mexico.

The shortnose sturgeon (*Acipenser brevirostrum*) inhabits the Atlantic seaboard of North America from New Brunswick, Canada to Florida. The species is anadromous, migrating from salt water to spawn in fresh water. It spends most of its life in its natal rivers or estuaries. The species feeds on a variety of bottom-dwelling organisms including worms, aquatic insect larvae, plants, snails, shrimp, and crayfish. The shortnose sturgeon population in Florida inhabits primarily nearshore and estuarine environments in northern portions of the state.

The smalltooth sawfish (*Pristis pectinata*) may also occur in the project area, although the species has not been documented in the project area vicinity. The species inhabits shallow coastal waters and estuaries. It is usually found in shallow waters very close to shore over muddy and sandy bottoms and is often found in sheltered bays, on shallow banks, and in estuaries or river mouths. The smaltooth sawfish feeds primarily on fish, but also ingests crustaceans. The current range of this species has contracted to peninsular Florida, and smalltooth sawfish are relatively common only in the Everglades region at the southern tip of the state. No accurate estimates of abundance trends over time are available for this species.

Johnson's seagrass (*Halophilia johnsonii*) is a very small (no larger than 2 inches) flowering marine plant with a very limited geographic distribution. The species grows on a variety of sediment types ranging from mud to coarse sand. It is found in estuaries and coastal lagoons along the Florida Coast from Sebastian Inlet to Biscayne Bay. Large patches of this species are reported to occur in Lake Worth Lagoon, south of West Palm Beach. Johnson's seagrass most frequently grows from the intertidal zone to a depth of approximately 6 ft below mean tidal height, although it has been reported at depths of 12 ft or deeper in clear water and tidal deltas adjacent to inlets.

In a letter received 24 May 2004, NMFS indicated that adverse impacts were unlikely to occur to the shortnose sturgeon, smalltooth sawfish, or any of the whale and turtle species listed above as a result of project activities (see Appendix B).

This FEIS will serve as a Biological Assessment for purposes of coordination in accordance with Section 7 of the Endangered Species Act. Designation of the Palm Beach Harbor ODMDS and Port Everglades Harbor ODMDS is not expected to adversely impact any threatened or endangered species.

3.3.1 Palm Beach Harbor

In a letter dated November 19, 1986, NMFS concurred with the Biological Assessment (BA) prepared by the USACE, which determined that populations of endangered/threatened species would not be adversely affected by the designation and use of an ODMDS for the Palm Beach Harbor. However, in light of the date of this initial coordination, an updated BA has been written to reflect current conditions and data. This BA was submitted to NMFS for concurrence as part of the DEIS. A copy of the updated BA is included in Appendix F.

3.3.2 Port Everglades Harbor

A similar updated BA was submitted to NMFS for the Port Everglades Harbor preferred site. A copy of this updated BA is included in Appendix G.

3.4 Hardgrounds

Areas of hard bottoms are scattered throughout the continental shelf of the southeastern United States. These areas have been termed "live bottoms" because they generally support a diversity of sessile invertebrates such as corals and sponges. Because of their biological and physical complexity, live bottom habitats attract both commercial and recreational fish species.

From West Palm Beach to the Florida Keys, there are generally three separate series of reefs or hard bottoms. Typically, there is a sand and rubble zone between the first and second hard bottom areas and more abundant sand pockets between the second and third hard bottom areas. The biological communities in and adjacent to these proposed hardbottom areas are relatively consistent, although their exact species composition may vary from site to site based on physical parameters such as distance from shore and hardground profile. No hardbottom natural reefs have been observed within the proposed project areas. The regional hardbottom habitat and the locations of hard bottom natural reefs near the proposed project areas are provided in figures 4 and 5, respectively.

Exposed nearshore and surf zone hard bottom in Palm Beach County consists of outcrops of coquina rock that are part of the Anastasia Formation. These outcrops, commonly referred to as "beach rock," are comprised of coquina shells, sand and calcareous limestone (Hoffmeister *et al*., 1967). The Anastasia formation extends from St. Augustine to slightly south of Boca Raton, where it grades into the contemporaneous Miami Oolite formation (Lovejoy, 1987). The Miami Oolite formation, outcropping in Broward County, is composed of minute calcareous spherules or ooids formed in seawater by precipitation of lime and eventually become bound by secondary calcite to form a hard substrate (Hoffmeister *et al*., 1967).

The classic reef distribution pattern described for southeast Florida reefs north of Key Biscayne consists of an inner reef in approximately 15 ft (8 m) to 25 ft (8 m) of water, middle patch reef zone in about 30 to 50 ft (9 to 15 m) of water, and an outer reef in approximately 60 ft (18 m) to 100 ft (30 m) of water. This general description was first published by Duane and Meisburger (1969) and has been the basis of descriptions of hardground areas north of Miami (Goldberg, 1973; Courtenay *et al*., 1974; Lighty *et al*., 1978; Jaap, 1984). The reefs north of Palm Beach Inlet do not show the same orientation to shore as those to the south and the classical "three reef" hardgrounds description begins to differ north of that inlet (Avent *et al*., 1977; Continental Shelf Associates, Inc., 1993).

The composition of hardground biological assemblages along Florida's east coast has been detailed by Goldberg (1970; 1973), Marszalek and Taylor (1977), Raymond and Antonius (1977), Marszalek (1978), Continental Shelf Associates, Inc. (1984; 1985; 1987; 1993), Wheaton (1987), and Blair and Flynn (1989). Although there is a large variety of hard coral species growing on the reefs north of Miami, these corals are no longer actively producing the reef features. The reef features seen north of Miami have been termed "gorgonid reefs" (Goldberg, 1970; Raymond and Antonius, 1977) because they support such an extensive and healthy assemblage of octocorals. Goldberg (1973) identified 39 species of octocorals from Palm Beach County waters. EPA (1992) lists 46 species of shallow water gorgonids as occurring along southeast Florida. Surveys by Continental Shelf Associates, Inc. (1984; 1985) identified 33 sponges, 21 octocoral, and 5 hard coral species on the offshore reefs off Ocean Ridge and 40 sponges, 18 octocoral, and 14 hard coral species on the offshore reefs off Boca Raton. Wheaton (1987) identified 17 octocoral species on the deep reefs off the City of Palm Beach. Blair and Flynn (1989) compared the reefs and hard bottom communities to

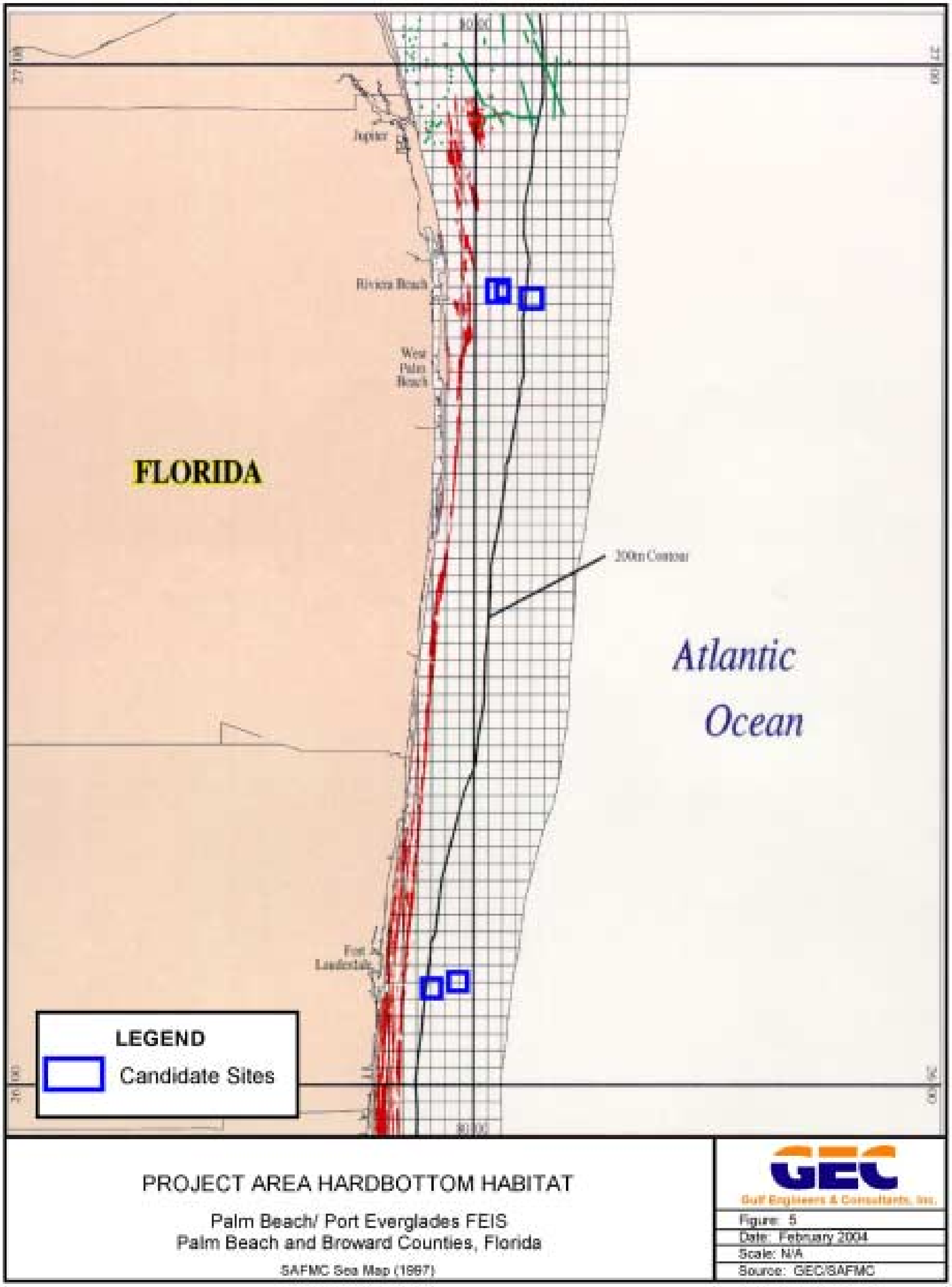
ATLANTIC COAST CONTINENTAL SHELF HABITAT

Palm Beach/ Port Everglades FEIS
Palm Beach and Broward Counties, Florida

SAFMC Sea Map (1997)

GEC
Gulf Engineers & Consultants, Inc.

Figure: 4
Date: February 2004
Scale: N/A
Source: GEC/SAFMC


Jupiter
Riviera Beach
West Palm Beach
FLORIDA
200m Contour
Atlantic Ocean
Fort Lauderdale
LEGEND
Candidate Sites
PROJECT AREA HARDBOTTOM HABITAT
Palm Beach/ Port Everglades FEIS
Palm Beach and Broward Counties, Florida
SAFMC Sea Map (1997)
GEC
Gulf Engineers & Consultants, Inc.
Figure: 5
Date: February 2004
Scale: N/A
Source: GEC/SAFMC

the offshore reef communities from Broward and Palm Beach counties. They documented a decrease in the hard coral species density moving northward from Dade County to Palm Beach County. Despite this gradual decrease in the density of hard coral species present, the overall hardground assemblage of hard corals, soft corals, and sponges seen along southeast Florida's offshore reefs remains remarkably consistent.

Several distribution surveys of hermatypic (reef-building) and ahermatypic (solitary) corals have been conducted near the proposed ODMDSs (Goldberg, 1973; Reed, 1980; Parker *et al*., 1983; and for overviews see Jaap, 1984; Porter, 1987). Typically, reef-building corals occur in the shallow water photic zone due to their symbiotic relationship with zooxanthellae (Jaap, 1984; Porter, 1987). Zooxanthellae are dinoflagellates, which require light to photosynthesize.

Ahermatypic corals can be found in deeper water since they do not have an obligate relationship with zooxanthellae. These types of corals require hard substrate to settle and survive. Colonies of the deep-water coral *Oculina varicosa* have been observed as scattered, isolated forms in the vicinity of the preferred (4.5-mile) site for Palm Beach Harbor (around 26°45'N and 79°59'W) (Reed, 1980). Colonies of *Oculina* in general extend north from Palm Beach Harbor and parallel the break between the edge of the continental shelf and the Florida-Hatteras slope, which parallels the 80°W meridian. The *Oculina* reefs occur approximately 1.7 nmi (3.2 km) west of the preferred (4.5-mile) site for Palm Beach Harbor and 7.4 nmi (13.7 km) west of the 9-mile candidate site; the reefs are not known to be in the vicinity of Port Everglades Harbor. Video surveys conducted by Continental Shelf Associates (CSA) did not reveal the presence of such substrates in the preferred (4.5-mile) ODMDS for Palm Beach Harbor.

The polychaete worm family Sabellariidae forms extensive reefs in shallow marine waters. These polychaetes use sand particles and a proteinaceous cement to build their dwelling tubes. As development continues, these tubes eventually form large colonies in the surf zone on shores exposed to the open sea. These colonies provide habitat to large invertebrate faunal communities of mostly crustaceans and molluscs, and provide food and shelter for transient and permanent fish faunas (Kirtley, 1974; Gore *et al*., 1978; Van Montfrans, 1981; Gilmore *et al*., 1981). Sabellarid reefs occur south of Cape Canaveral and near shore in up to 33 ft (10 m) of water along Palm Beach and northern Broward counties (Jones *et al*., in Seaman, 1985).

Rock outcrops serve as a habitat for epibenthic species that can secure themselves to the hard substrate. The exact composition of the community developed around such outcrops depends upon the physical features of the specific outcrop, its distance from shore, and its vertical relief. The width and vertical profiles of an outcrop formation determine its overall significance both as a biological resource and as a natural wave break. Larger outcrops normally show an increase in habitat heterogeneity, which in turn is reflected in increased biomass, greater species abundance, and increased biodiversity (Peters and Nelson, 1987; Luckhurst and Luckhurst, 1978; Vare, 1991).

The epibenthic community associated with low profile, smooth, intertidal and subtidal rock outcrops is best characterized as an algal mat community dominated by a number of filamentous algal species, including *Cladophora* sp., *Chaetomorpha linum*, and *Gelidiopsis panicularis*. Other algal species observed commonly only on subtidal rocks include *Jania rubens*, *Wrangelia argus*, and *Bryothamnion seaforthii*. The green alga *Ulva lactuca* and the barnacle *Tetraclita squamosa* are dominant species on exposed intertidal rocks (Continental Shelf Associates, Inc., 1984). Along rock outcrops offering greater profile, the algal community is dominated by *Caulerpa sertularioides*, *Dasycladus vermicularis*, *Pidina* sp., *Dictyota* sp., *Halimeda* sp., and *Lyngbya* sp. (Vare, 1991). Other large macroalgal species characteristic of southeast Florida nearshore rock outcrops are *Bryothamnion seaforthii*, *Wrangelia argus*, *Codium* sp., *Gracilaria* sp., and *Caulerpa racemosa* (Continental Shelf Associates, 1985). The type of marine algae present at a given location is dependent upon the chemical nature of the substratum and the physical nature of the environment at that location. Taylor (1979) suggested that along the nearshore rock outcrops of southeast Florida, wave action and sand scouring are the factors controlling algal community distribution.

Commercially, the most important invertebrate species directly associated with these hardground areas is the Florida lobster, *Panulirus argus*. The reefs are also economically important as the foundation for a thriving sports diving industry. Herrema (1974) listed 206 species of primary reef fish as occurring off Palm Beach and Broward counties. This assemblage is numerically dominated by wrasses, damselfishes, sea basses, parrotfishes, grunts and angelfishes. The precise composition of the fish assemblage associated with any given location along these hardground areas is dependent upon the structural complexity of the reef at that location.

3.5 Fish and Wildlife Resources

Several species of marine mammals, in addition to those listed in Section 3.3 above, may occur in area waters. The most abundant and widespread inshore mammal is the bottlenose dolphin (*Tursiops truncatus*) while the spotted dolphin (*Stenella plagiodon*) is probably the most common species offshore (Schmidly, 1981). There have been numerous reports of stranding of the short finned pilot whale (*Globicephala macrorhyncha*) along the southeast coast of Florida. Other marine mammals are infrequently (sometimes singular or unverified) reported from the eastern coast of Florida include the Antillean beaked whale (*Mesoplodon europaeus*), pygmy sperm whale (*Kogia breviceps*), goose-beaked whale (*Ziphius cavirostris*), killer whale (*Orcinus orca*), common dolphin (*Delphinus delphis*), long-snouted dolphin (*Stenella longirostris*), and the California sea lion (*Zalophus californianus*).

The biological communities addressed in the following sections are plankton, benthos including benthic macrofauna, benthic meiofauna, and epibenthic invertebrates, and nekton. Species of special concern, which may utilize the proposed vicinity of the proposed ODMDSs, are also addressed. Disposal impacts on planktonic communities are generally considered to be temporary, while larger, motile organisms (nekton) are able to avoid disposal operations and localized areas of poor water quality.

3.5.1 Plankton

Plankton includes plants and animals that live in the water column and are passively carried by the currents. There are two types of plankton: tiny plants called phytoplankton, and weak-swimming animals called zooplankton. Some are larval forms that will grow into non-planktonic adults. Others will remain planktonic for their entire lives.

Specific studies of plankton are lacking in the vicinity of the alternative ODMDSs. Many species of phytoplankton and zooplankton are cosmopolitan. Endemic planktonic populations are rare (Lackey, 1967; Wood, 1965; Steidinger, 1973). As a result, it is expected that planktonic species similar to those reported from southeastern U.S. estuaries and coastal waters are present in the vicinity of the alternative ODMDSs. Over 900 species of diatoms and 400 species of dinoflagellates have been reported from waters along southeastern United States and Gulf coasts (Simmons and Thomas, 1962;

Hurlburt, 1967; Marshall, 1971; Dardeau *et al*., in press). The dominant components of the phytoplankton community are diatoms (*Skeletonema costatus*, *Chaetoceros* spp., *Coscinodescus* spp., *Nitzschia seriata*, *Rhizosolenia* spp., *Thalassiothrix frauenfeldii*, *Thalassionema nitzschioides*, and *Asterionella japonica*) and dinoflagellates (*Ceratium hircus, Gymnodinium splendens, Glenodinium* spp., *Gyrodinium* spp., *Polykrikos* spp., *Peridinium* spp., *Gonyaulax* spp., and *Goniodoma* spp.) (Dardeau *et al*., in press). Other macroplankton from the surface to depths of 750 m included eight heteropod and 15 thecosome species (Michel and Michel, 1991).

Species abundance and density of phytoplankton is usually inversely related to increasing salinity (i.e., from the head of the estuary seaward) (Hurlburt, 1967; Kinne, 1967). However, the highest species diversity has been reported from areas affected by river discharge where both riverine and oceanic species coexist. Seasonally, phytoplankton biomass and production is highest during warmer months in estuarine and nearshore waters (Dardeau *et al*., in press). This seasonality is thought to be influenced by riverine flow rates into estuaries and estuarine discharge into nearshore waters. Two surveys comparing phytoplankton assemblages over the continental shelf of Florida and in the Gulf Stream detected some differences in species composition and abundance. Over the shelf and western border of the Gulf Stream, diatoms were the dominant component of the phytoplankton community. In the Gulf Stream, coccolithophores, pyrrhophyceans, and silicoflagellates increased in diversity and abundance (Hurlburt, 1967; Marshall, 1971).

Copepods are normally the dominant component of the zooplankton community, but other organisms, particularly the larvae of benthic organisms, can be seasonally abundant (Dardeau *et al*., in press). The copepods *Acartia tonsa* and *Paracalanus crassirostris*, and the appendicularian *Oikopleura dioica*, can be expected to dominate the zooplankton community. Copepods typically dominate estuarine and nearshore zooplankton communities throughout the south-eastern United States. *Acartia tonsa*, because of its large size, most frequently dominates the zooplankton community biomass (Dardeau *et al*., in press). Typically, zooplankton abundance and biomass are highest during summer months.

3.5.2 Benthos and Nekton

The benthos consists of plants and animals that live permanently in or on soft and rocky bottoms. Benthic animals are found at all depths and are associated with all substrates. Epifauna contains the largest amount of benthic animals. Specifically, these are the animals that live on or are attached to the surface of rocky areas or firm sediments. Animals that live buried in the substrate are associated with soft sediments such as sand or mud.

The macrofauna are the animals retained by mesh sieves greater than 0.5 mm. Meiofauna are microorganisms that can be caught in sieves with holes ranging between 0.062 mm and 0.5 mm. Individuals belonging to meiofaunal group include foraminifera, copepods, nematodes, and podocopid ostracods.

The nekton characterizes those species that actively swim and move freely in the ocean. The only invertebrate animals among this group are the squid and a few species of shrimp. The other members of the nekton are vertebrates such as fishes, reptiles and mammals.

3.5.3 Palm Beach Harbor

A 1989 report of a survey conducted by CSA in the vicinity of the preferred (4.5-mile) site showed that annelids, molluscs, and arthropods were the dominant benthic taxonomic groups in terms of abundance and number of taxa. The percentage of total abundance (number of taxa) was 59% (38) for annelids, 25% (33) for molluscs, and 6% (40) for arthropods. This survey verified the findings of a November 1984 survey, which showed similar macrofauna distribution. One station in this survey was located close to the vicinity of the preferred (4.5-mile) ODMDS and showed that the percentage of total abundance (number of taxa) was 67% (52) for annelids, 23% (15) for molluscs, and 3% (12) for arthropods. Data was further collected in 1998. This data indicated that annelids and arthropods dominated the alternative sites.

The 1989 study showed 124 families and a mean density of 2,246 individuals/m^2 (CSA, 1989). Annelids (51%) and arthropods (9%) were the most abundant groups of the total fauna.

In a 1998 survey, EPA collected taxonomic data for the alternative sites. The taxonomic composition consisted of 1,318 individuals and 160 taxa across 71 families (see Appendix H). Densities ranged from 305 to 592 individuals/m^2 with a mean density of 421 individuals/m^2. This contrasted with a 1984 study that found 392 taxa present and a mean density of 2,840 individuals/m^2 (Barry Vittor and Associates, 1985).

The 1998 survey contained information regarding the infaunal composition of the alternative sites. At the preferred (4.5-mile) site, annelids and arthropods comprised 42% and 13% of the total community respectively. The mean number of taxa at the site was 46 and the mean density was 405 individuals/m^2. The candidate (9-mile) site contained annelid and arthropod assemblages comprising 80% and 5%, respectively, of the total community. The mean number of taxa at this site was 62; the mean density at the site was 433 individuals/m^2.

The most abundant macrofaunal taxonomic group represented in samples from the vicinity of the preferred (4.5-mile) site was bivalves, which could not be identified to family levels. Polychaete families characteristic of the area included Paraonidae and Spionidae. The isopod family Anthuridae was found in high numbers only at one station of the survey area and was absent from some of the other stations.

Vare (1991) listed a total of 42 encrusting and 33 non-encrusting macroinvertebrate species found along the nearshore rock outcrops of Palm Beach County. Six phyla were observed in order of descending percent composition: 45% for Cnidaria (26% for Hydrozoa and 19% for Anthozoa), 17% for Porifera, 11% for Mollusca, 11% for Arthropoda, 9% for Echinodermata, and 7% for Annelida. Those species with the highest frequency of occurrence were the star coral (*Siderastrea radians*), various species of wine glass hydroids (*Campanularia* spp.), several species of tube type sponges, the boring sponge (*Cliona celata*), the worm rock building polychaete (*Phragmatopoma lapidosa*), and the fire coral hydroid (*Millipora alcicornis*) (Vare, 1991). The encrusting macroinvertebrate community does not appear to vary significantly by season (Continental Shelf Associates, Inc., 1985). Mobile epibenthic species such as sea urchins, brachyuran and xanthid crabs, and the Florida lobster, *Panulirus argus,* were more frequently observed in the spring and summer than in the winter. Most of these species were seen in holes and crevices along the vertical face of rock outcroppings (CSA, 1985; Vare, 1991).

Benthic epifauna were collected by trawl from the vicinity of the preferred (4.5-mile) site. The most common invertebrates collected were Caribbean shrimp of the family Pandalidae. Only 34 individual invertebrates were collected in this survey. The dominant fish collected was the Gulf Stream flounder (*Citharichthys arctifrons*). Other fish species frequently represented in samples include the spot (*Leiostomus xanthurus*), the blackmouth bass (*Synagrops bellus*), and the small scale lizardfish (*Saurida caribbaea*) (CSA, 1989).

Surf zone fish communities are typically dominated by relatively few species (Modde and Ross, 1981; Peters and Nelson, 1987). Vare (1991) observed seven species of fish considered independent of reef or hard bottom outcrops in the nearshore sand bottom areas off Palm Beach County. Listed in order of their frequency (most common to least), these fish were the Atlantic threadfin herring (*Opisthonema oglinum*), blue runner (*Caranx crysos*), spotfin mojarra (*Eucinostomus argenteus*), southern stingray (*Dasyatis Americana*), greater barracuda (*Sphyraena barracuda*), yellow jack (*Caranx bartholomaei*), and the ocean triggerfish (*Canthidermis sufflamen*), none of which are of local commercial value. Most of the fish making up the inshore surf community tend to be either small species or juveniles (Modde, 1980).

Vare (1991) indicates that the most frequently observed, year-round resident fish species along the nearshore rock outcrops of Palm Beach County include the sergeant major (*Abudefduf saxatilis*), spottail pinfish (*Diplodus holbrooki*), cocoa damselfish (*Pomacentrus variabilis*), slippery dick (*Halichoeres bivittatus*), and doctorfish (*Acanthurus chirurgus*). All these species are considered to be reef fish with no commercial value and can be assumed to be drawn to the nearshore rock outcrops because of the hard substrate habitat (Starck, 1968).

According to the USFWS (1982), nekton of the nearshore Atlantic Ocean along West Palm Beach can generally be grouped with association to reefs, open waters off West Palm Beach and open waters of the Atlantic. The most abundant reef species include red snapper, king mackerel, cero, mutton snapper, yellowtail snapper, red grouper, gray snapper, grunts, Warsaw grouper, great barracuda, jewfish, tripletail, lane snapper, Nassau grouper, black grouper, gag, greater amberjack, wrasses, parrotfish, damselfish, butterflyfish, and surgeonfish. The major invertebrates at reef sites are the stone crab and spiny lobster. Species in open waters off West Palm Beach include sharks, skates, rays, grouper, mullet, snapper, spotted seatrout, red drum, black drum, gulf kingfish, sheepshead, striped mullet, Florida pompano, bluefish, cobia, Atlantic spadefish, little tunny, Spanish mackerel, king mackerel, sea catfish, bay anchovy, tarpon, ladyfish, permit, yellowtail snapper, red grouper, gray snapper, grunts, great barracuda, jewfish, snook, gag, greater amberjack, pinfish, white mullet, crevalle jack, silver perch, striped mojarra, blue runner, Atlantic bottlenose dolphin, Atlantic spotted dolphin, short-finned pilot whale, pygmy sperm whale, and killer whale. The major invertebrates in open water are the pink shrimp, blue crab, stone crab, and spiny lobster. Species that generally may be found in open waters of the Atlantic Ocean include cero, Atlantic bonito, sailfish, vermilion snapper, tilefish, dolphin, black grouper, greater amberjack, swordfish, blue marlin, white marlin, skipjack tuna, and blackfin tuna.

3.5.4 Port Everglades Harbor

Surveys conducted in February and November of 1984 (Barry Vittor and Associates, 1985) near the preferred (4-mile) site showed that annelids, molluscs, and arthropods were the dominant benthic taxonomic groups in terms of abundance and number of taxa. The November survey showed the percentage of total abundance (number of taxa) was 65% (55) for annelids, 10% (22) for molluscs, and 13% (21) for arthropods. Goldberg et al. (1985) reported polychaetes as the dominant taxon from his infaunal survey off northern Broward County. Data collected by EPA in 1998 indicated that annelids and arthropods dominated the alternative sites.

In the 1998 EPA survey of the alternative sites, the taxonomic composition consisted of 1,973 individuals and 159 taxa across 65 families (Appendix H). Densities ranged from 488 to 1,239 individuals/m^2 with a mean density of 756 individuals/m^2. This contrasted with a 1984 study that found 453 taxa present and a mean density of 4,637 individuals/m^2 (Barry Vittor and Associates, 1985).

The 1998 survey revealed that annelids were the most abundant group at the alternative sites, representing 50% of the total fauna. The arthropods were the second largest group overall with 37% of the total fauna. Overall, macrofaunal samples were dominated in numbers by annelids and arthropods. All alternative sites were similar in that they had a similar number of taxa dominated by the same major taxonomic groups.

At the preferred (4-mile) site, arthropods were the most abundant group overall representing 53% of the total fauna. The ampeliscid amphipods comprised 24% and annelids comprised 37% of the total fauna. Mean densities among stations at the site ranged from 392 to 440 individuals/m^2 and total taxa ranged from 73 to 77. Conversely, annelids and arthropods comprised 62% and 23%, respectively, of the total fauna at the candidate (7-mile) site. Mean densities at this site varied from 488-1,239 individuals/m^2, while total taxa ranged from 38 to 79.

Larger members of the invertebrate macrofauna seen occasionally in these offshore soft bottom areas between the second and third reef lines include the queen helmet (*Cassia madagascariensis*), the king helmet (*Cassia tuberosa*), Florida fighting conch (*Strombus alatus*), milk conch (*Strombus costatus*), Florida spiny jewel box (*Arcinella cornuta*), decussate bittersweet (*Glycymeris decussata*), calico clam (*Macrocallista maculata*), tellin (*Tellina* sp.), and cushion star (*Oreaster reticulates*) (Courtenay *et al*., 1974). The Florida lobster moves through this area as they migrate from offshore to nearshore areas.

Benthic epifauna in the area of the alternative ODMDS for Port Everglades Harbor is likely to be similar to those in the Palm Beach Harbor area. The composition of benthic communities in Broward County has been detailed by Marsh *et al*. (1980) and Turberville and Marsh (1982).

Fish assemblages associated with beach rock outcrops along the southeastern Florida coastline essentially comprise a mixture of coastal pelagic, surf zone, and reef fishes attracted to the cover and food source provided by these nearshore hard substrates. The coastal pelagic species seen are primarily migratory species including the Spanish mackerel (*Scomberomorus maculatus*), bluefish (*Pomatomus saltatrix*), mullets (*Mugil* sp.), and some jacks (*Caranx* sp.) of which only the Spanish mackerel and mullet are of any local commercial value. These species may be seen near rock outcrops during their migrations but they are not specifically attracted to them. Surf zone fishes as a group are those species that typically occur on open sand or shell bottom throughout the western Atlantic and Gulf of Mexico. Typical surf zone fish species seen along the rock outcrops of southeast Florida include Atlantic croaker (*Micropogonias undulates*), pompano (*Trachinotus carolinus*), jacks, snook (*Centropomus undecimalis*), anchovies (*Anchoa* sp.), and herrings (*Clupea* sp.). These species are not confined to nearshore rock outcrops and occur along the sandy periphery of such outcrops when they exist in the nearshore zone (Herrema, 1974; Futch and Dwinnell, 1977; Gilmore, 1977; Gilmore *et al*., 1981). Reef fishes are always associated with some form of bottom structure, man-made or natural. Although reef fish reach their peak abundance along the offshore reefs, the presence of the Anastasia and Miami Oolite Formations in the nearshore environment attracts some of these species. Species seen along the nearshore rock outcrops include grunts, snappers, groupers, and wrasses as well as some of the damselfish, blennies, gobies, angelfishes and parrot fishes of which only the snappers and groupers are of any local commercial value (Courtenay *et al*., 1980).

Herrema (1974) reported over 300 fish species as occurring off southeast Florida. Approximately 20% of these species were designated as "secondary" reef fish. Secondary reef fish are fish species that, although occurring on or near reefs, are equally likely to occur over open sand bottoms. Many of these species such as sharks, jacks, mullet, bluefish, sailfish, and marlin (none of which have significant local commercial value) are pelagic or open water species and are transient through all areas of their range. Fish species specifically associated with the sand flats and soft bottom areas between the first and second reefs include lizardfish (*Synodus* sp.), sand tilefish (Malacanthus *plumieri*), yellow goatfish (*Mulloidichthys martinicus*), spotted goatfish (*Pseudupeneus maculates*), jawfish (*Opistognathus* sp.), stargazer (*Platygillellus (Gillellus) rubrocinctus*), flounder (*Bothus* sp.), and various species of gobies and blennies. None of these fish have significant local commercial value.

3.5.5 Comparison with Miami ODMDS

Table 5 presents a comparison of faunal assemblages between the alternative ODMDSs and an ODMDS off the coast of Miami.

Although abundance values differ between the sites, annelids, molluscs, and arthropods comprise the majority of taxa at all three sites. Annelids constitute a majority or plurality of taxa at all three sites. Shrimp are the most common invertebrates at the two sites sampled, although the dominant and common fish species differ. Despite the variation in individual species, the three sites appear to contain similar environments. It may be surmised from this comparison that the habitat at each of the proposed sites is representative of southeastern Florida slope environment and does not constitute a unique resource.

3.6 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act, as amended, PL 104-208, addresses the authorized responsibilities for the protection of Essential Fish Habitat (EFH) by NMFS in association with regional fishery management councils (FMC). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." This definition extends to habitat specific to an individual species or group of species; whichever is appropriate within each Fishery Management Plan (FMP). Habitat Areas of Particular Concern (HAPC) have also been designated for the Southeast. These areas are subsets of EFH that are rare, susceptible to human degradation, ecologically important or located in an ecologically stressed area. Any Federal agency that proposes any action that potentially affects or disturbs any EFH must consult with the Secretary of Commerce and Fishery Management Council authority per the

Table 5. Faunal Assemblage Comparison by Site

Biological Community	Taxonomic Group	Palm Beach ODMDSs*	Port Everglades ODMDSs*	Miami ODMDS
Benthic Macrofauna	Annelids	59% (51%)	65% (50%)	37%
Benthic Macrofauna	Molluscs	25%	10%	14%
Benthic Macrofauna	Arthropods	6% (9%)	13% (37%)	33%
Epibenthic	Common Invertebrates	Caridean shrimp (*Pandalidae*)	Not specified	Pink shrimp (*Penaeus duorarum*)
Nekton	Dominant Fish	Gulf Stream flounder (*Citharichthys arctifrons*)	Not specified	Largescale tonguefish (*Symphurus minor*)
Nekton	Common Fish	Spot Blackmouth bass Smallscale lizardfish	Not specified	Longspine scorpionfish Freckled skate Horned searobin Spotted hake

Note: *Percentages in parentheses reflect data from the 1998 EPA Survey.

Source: Palm Beach and Port Everglades ODMDS DEIS, Miami ODMDS FEIS, EPA 1999.

Magnuson-Stevens Act, as amended. Interim final rules were published on December 19, 1997 in the Federal Register (Vol. 62. No. 244) to establish guidelines for the identification and description of EFH in fishery management plans. These guidelines include impacts from fishing and non-fishing activities as well as the identification of actions needed to conserve and enhance EFH. The rule was established to provide protection, conservation, and enhancement of EFH.

The areas proposed for designation as disposal sites for this project fall under the jurisdiction of the South Atlantic Fishery Management Council (SAFMC). The SAFMC has identified and described EFH for hundreds of marine species covered by 20 FMPs. A list of species managed by the SAFMC can be found in Table 6. The SAFMC extends from the northern coast of North Carolina south to the Florida Keys. The SAFMC has identified several types of EFH that occur in estuarine and marine conditions. These EFH types and their corresponding categories can be found in Table 7. Additional information on EFH with respect to the proposed project is included in the EFH Assessments (Appendix I).

Table 6. Species and Highly Migratory Species Managed by the South Atlantic Fishery Management Council

Managed Species		Highly Migratory Managed Species	
Brown shrimp	Mutton snapper	Albacore tuna	Oceanic whitetip shark
White shrimp	Blackfin snapper	Atlantic bigeye tuna	Bigeye thresher shark
Pink shrimp	Silk snapper	Atlantic bluefin tuna	Great hammerhead shark
Rock shrimp	White grunt	Atlantic skipjack tuna	Nurse shark
Royal red shrimp	Greater amberjack	Atlantic yellowfin tuna	Blacktip shark
Red drum	Blueline tilefish	Swordfish	Bull shark
Snowy grouper	Golden tilefish	Blue marlin	Lemon shark
Yellowedge grouper	King mackerel	White marlin	Blacknose shark
Warsaw grouper	Spanish mackerel	Sailfish	Finetooth shark
Scamp	Cobia	Longbill spearfish	Scalloped hammerhead shark
Speckeled hind	Dolphin (fish)	White shark	Dusky shark
Jewfish	Golden crab	Bignose shark	Sandbar shark
Wreckfish	Spiny lobster	Caribbean reef shark	Spinner shark
Red snapper	Coral	Night shark	Tiger shark
Vermilion snapper	Calico scallops	Silky shark	Sand tiger shark
Grey snapper		Longfin mako shark	Bonnethead shark
Red porgy		Shortfin mako shark	Atlantic sharpnose shark
		Blue shark	

Source: NMFS, February 2002.

3.7 Physical Oceanography

3.7.1 Tides and Currents

Circulation over most continental shelves is governed primarily by tides and winds. In addition to these factors, circulation off the southeast coast of Florida is strongly influenced by the nearby Florida Current. The Florida Current is the portion of the Gulf Stream system that connects the Loop Current in the Gulf of Mexico to the Gulf Stream as it proceeds through the Straits of Florida and into the open Atlantic Ocean (Lee and Mayer, 1977). The degree of coastal influence exerted by this current is variable and reflects the dynamic nature of the Gulf Stream system.

The Florida Current has a variable influence on circulation in the vicinity of the alternative sites depending on the degree of intrusion over the continental shelf (EPA, 1973). At certain times of the year, the southward flow of continental shelf surface waters is interrupted by intrusions of the Florida Current onto the shelf, which then carries shelf waters north. When the western edge of the Florida Current is seaward of the continental shelf, cyclonic “spin-off” eddies (current reversals), with average diameters of 10 km to 30 km, are formed (Lee, 1975; Lee and Mayer, 1977). These cyclonic eddies flow to the north at speeds of 20 to 50 cm/sec, replacing coastal waters with those from the

Table 7. Essential Fish Habitat and Habitat Areas of Particular Concern Identified for Management by the South Atlantic Fishery Management Council

Essential Fish Habitat		HAPC
Estuarine Areas	**Marine Areas**	**Area Wide**
Estuarine emergent wetlands	Live/Hard bottoms	Council designated artificial reef special management zones
Estuarine scrub/shrub mangroves	Coral and coral reefs	Hermatypic coral habitat and reefs
Submerged aquatic vegetation	Artificial/manmade reefs	Hard bottoms
Oyster reefs and shell banks	*Sargassum*	Hoyt Hills
Intertidal flats	Water column	*Sargassum* Habitat
Palustrine emergent and forested wetlands		State designated areas of importance to managed species
Aquatic beds		Submerged aquatic vegetation
Estuarine water column		
		Florida
		Blake Plateau (manganese outcroppings)
		Biscayne Bay
		Card Sound
		Florida Bay
		Florida Keys National Marine Sanctuary
		Jupiter Inlet Point
		Mangrove habitat
		Marathon Hump
		Oculina Bank
		Phragmatopoma reefs
		The Wall (Florida Keys)

Source: NMFS, February 2002.

Florida Current (Lee, 1975; Lee and Mayer, 1977). Consequently, cyclonic eddies can play an important role in coastal exchange processes. Eddy formation occurs approximately once a week and is thought to be related to local atmospheric forces (Lee and Mayer, 1977).

The western boundary of the Florida Current is distinguished from the inshore waters by a sharp rise in sea surface temperature. Fornshell (2000) studied the movement of the western boundary near Fort Pierce for 51 days in January to March, 1998. The results of the study indicated that the average distance from the shore to the western boundary of the Florida Current was 29.3 km, in the range of 8 to 60 km. Five incursions of the Florida Current onto the continental shelf occurred during a study, with an average recurrence interval of 10 days. This periodicity is approximately equal to that of the spin-off eddies reported by Lee (1975) and Lee *et al*. (1977) based on measurements made south of the study area. At the site of the study, the distance from shoreline to the shelf break is about 40 km, although the study area is north of the current proposed project area.

Bottom currents over the continental shelf and slope in the project areas generally flow from south to north with minor variations in direction. Current velocity decreases substantially with increasing depth (Emery *et al*., 1970). Bottom currents at the shelf break have an estimated range of 20-40 cm/sec (Emery *et al*., 1970). It is expected that ocean currents near the alternative ODMDSs generally move along a north-south axis. The predominant current is to the north, and current speeds are highest in surface waters, decreasing with depth. Mean current speeds in surface waters can range from 62 cm/sec in winter to 95 cm/sec during spring and summer (Lee and Mooers, 1977). Maximum currents are 50-150 cm/sec to the north and 50 cm/sec to the south, and a mean northerly flow in near-bottom waters of 3.5 cm/sec has been reported (Lee and Mooers, 1977). Maximum currents are 50-150 cm/sec to the north and 50 cm/sec to the south. A mean northerly flow in near-bottom waters of 3.5 cm/sec, with maximum flows of 27 cm/sec to the north and 23 cm/sec to the south has been reported (Lee and Mooers, 1977).

The USACE Water Experiment Station (WES) has a major database of wave information including storm events near U.S. coastlines. Wave data collected from five stations close to the project sites are presented in Appendix J. A summary of those data is provided in Table 8.

In 1998 WES conducted an initial dredged material fate study, *Dispersion Characteristics for Palm Beach and Port Everglades ODMDSs*. EPA later expressed concern regarding the applicability of data collected from the Navy Acoustic Doppler Current Profiler (ADCP). In 2001, WES conducted an additional study, *Port Everglades/Palm Beach Dredged Material Fate Studies*, for further analysis as well as to reanalyze the representative velocities of the region. The Palm Beach Harbor alternative sites are about 70 km north of the ADCP. Despite these efforts, WES was not able to collect any additional data closer to the Palm Beach Harbor site. The results of the study indicate that the predominant current flowing along the shelf is expected to be similar in magnitude at the Palm Beach Harbor and Port Everglades Harbor sites. This similarity is due to a dominant northward current (steered by the shelf break) as well a mean Gulf Stream position located a similar distance from shore at both locations. Concern has been expressed by EPA regarding the fate of the dredged material disposed at the proposed ODMDSs due to their proximity to the Gulf Stream and its spin-off eddies. The study results note that the small distance between shoreline and shelf break in the study region (about 10 km) should constrain the formation and propagation of eddies (about 10 to 30 km in diameter), compared to the areas where the shelf is much wider. Eddies would be constrained in a similar way, however; consequently, similar effects of spin off eddies would be expected at the ODMDS and ADCP sites due to the similarity of shelf bathymetry at three sites. Therefore, the currents at all sites are expected to be similar in the light of the length scale of eddies, similarities in proximity to the western boundary of the Florida Current, and similarities in shelf bathymetry.

At the ADCP site, velocity data from 1995-1997 were analyzed by north/south and east/west components (WES, 1998). The results are tabulated in tables 9 and 10. The average east/west and average north/south velocities are the residual velocity components for each year. Detailed discussion and figures of these velocity components are presented in Appendix K.

Table 8. Summary of Wave Information in the Vicinity of Project Sites

Station	Summary of wave information (1976-1995)		
Station 9 26.00 N 80.00 W Depth: 220 m	Max Hm0 (m): 6.9	Max wind speed (m/sec): 29	Mean Hm0 (m): 0.9
	Max Tp (sec): 10	Max wind direction (deg): 65	Mean Tp (sec): 7
	Max Dp (deg): 54		
Station 10 26.25 N 80.00 W Depth: 183 m	Max Hm0 (m): 7.3	Max wind speed (m/sec): 25	Mean Hm0 (m): 1.0
	Max Tp (sec): 11	Max wind direction (deg): 55	Mean Tp (sec): 8
	Max Dp (deg): 50		
Station 11 26.50 N 80.00 W Depth: 90 m	Max Hm0 (m): 6.8	Max wind speed (m/sec): 23	Mean Hm0 (m): 1.0
	Max Tp (sec): 10	Max wind direction (deg): 15	Mean Tp (sec): 8
	Max Dp (deg): 40		
Station 12 26.75 N 80.00 W Depth: 45 m	Max Hm0 (m): 6.4	Max wind speed (m/sec): 23	Mean Hm0 (m): 1.0
	Max Tp (sec): 11	Max wind direction (deg): 60	Mean Tp (sec): 8
	Max Dp (deg): 54		
Station 13 27.00 N 80.00 W Depth: 45 m	Max Hm0 (m): 7.6	Max wind speed (m/sec): 30	Mean Hm0 (m): 1.1
	Max Tp (sec): 11	Max wind direction (deg): 45	Mean Tp (sec): 9
	Max Dp (deg): 72		

Notes: Hm0: significant wave height.
Tp: spectral peak period (corresponds to the highest peak in the frequency spectrum)

Source: http:// bigfoot.wes.army.mil/c201.html

Table 9. East/West Velocity Components in the Vicinity of the Project Sites

Direction	Depth	Velocity (cm/sec) Years 1995	1996	1997
Max. East	Surface water (6m -10 m)	**150**	**150**	125
	Deep water (102 m –106 m)	45	50	50
Max. West	Surface water (6m -10 m)	80	**235**	135
	Deep water (102 m –106 m)	40	50	25
Avg. East	Surface water (6m -10 m)	25	25	25
	Deep water (102 m –106 m)	5	5	5
Avg. West	Surface water (6m -10 m)	8	12	15
	Deep water (102 m –106 m)	5	2	2
Avg. East/West*	Surface water (6m -10 m)	20	20	25
	Deep water (102 m –106 m)	0	2	0

Note: *Positive values indicate an eastward direction.

Source: WES, 1998.

Table 10. North/South Velocity Components in the Vicinity of the Project Sites

Direction	Depth	Velocity (cm/sec) Years 1995	1996	1997
Max. North	Surface water (6m -10 m)	255	490	**530**
	Deep water (102 m –106 m)	100	130	30
Max. South	Surface water (6m -10 m)	150	**320**	150
	Deep water (102 m –106 m)	100	75	40
Avg. North	Surface water (6m -10 m)	75	70	100
	Deep water (102 m –106 m)	20	25	25
Avg. South	Surface water (6m -10 m)	25	20	10
	Deep water (102 m –106 m)	20	15	10
Avg. North/South*	Surface water (6m -10 m)	65	60	100
	Deep water (102 m –106 m)	0	20	20

Note: *Positive values indicate a northward direction.

Source: WES, 1998.

As presented in tables 9 and 10, maximum currents were observed at surface water, and minimum currents were observed in deep water. Maximum currents in each primary direction were indicated as bold in these tables.

Directional distribution of velocities as a function of depth was further examined from the ADCP data (WES, 1998). Four locations in the water column (bins) and twelve compass angle bands were defined during the analysis. Velocities with exceedances of 50% (V_{50}), 10% (V_{90}), 5% (V_{95}), and 1% (V_{99}) were identified for each angle band. The highest velocities were observed in bin 25 (at 10-m depth from the water surface) in 1997. These velocities were used in short-term and long-term dredged material fate studies (Table 11).

Table 11. Velocities Simulated in Fate Studies

Direction and Percentile	Velocity Magnitude (cm/sec)
W50	20
W90	27
W95	40
W99	57
N50	53
N90	128
N95	149
N99	200

Source: WES, 1998

The directional distribution of velocities reflected in the data indicates that the most prevalent currents are headed to north (Angle Band 1, 0-45 degrees) and these currents also have the greatest average velocity. With the shoreline orientation nearly north/south, only the first 5 degrees from Angle Band 1 could possibly direct sediment shoreward toward the reef system. This shoreward directed band (5 degrees) only occurred during 3-10% of the total data collection period. Angle Bands 5 (180-202.5 degrees) through 12 (337.5-360 degrees) also have shoreward directed currents. Shoreward directed currents from these angle bands occurred during 7.5-15.5% of the total data collection time period. Overall shoreward directed currents occurred during 17.5-19.4% of the total data collection period including the 5-degree portion of Angle Band 1 (WES, 1998). Detailed discussion of the velocity analysis, and the figures of directional distribution of velocities, cumulative probability distribution and velocity profiles for selected angle bands are presented in the original WES study included in Appendix K of this report.

3.8 Water Quality

EPA conducted an environmental characterization survey of the alternative ODMDSs in 1998. The methods and results of this survey are detailed in *Sediment and Water Quality of Candidate Ocean Dredged Material Disposal Sites for Port Everglades and Palm Beach, Florida*. This survey covers samplings for three alternative sites and one interim site for the Palm Beach Harbor ODMDS, and two alternative sites and one interim site for the Port Everglades Harbor ODMDS as determined by EPA and the USACE. Aspects of the water quality survey include the measuring of temperature, transmissivity, salinity, dissolved oxygen, turbidity and total suspended solids, trace metals, pesticides and PCBs, and total petroleum hydrocarbons. The results of this survey along with previous surveys and studies conducted in the area are summarized below. Detailed discussion is provided in the original report, which is included in Appendix H.

3.8.1 Water Temperature

The Florida Ocean Sciences Institute (1971, in EPA, 1973) reported annual temperature variations of 21.1° Celsius (C) to 30.0 °C. Over the continental shelf, the water column is generally well mixed from mid-August to late April. Thermal stratification begins to appear in April and continues through mid-August with vertical temperature variations in the summer of up to 12° C at the 90 ft (27 m) depth contour.

Lee and Mooers (1977) reported annual mean water temperatures for the offshore area of Miami ranging from 26° C at 328 ft (100 m) to nearly 10° C at a depth of 656 ft (200 m). The authors also cite Brooks (1975), who reported two years of temperature data collected from a station located about 5.5 nmi (10 km) south of Miami in waters of a similar depth (689 ft; 210 m). Mean seasonal surface water temperatures varied from 24° C to 29° C, while bottom waters ranged from 7.9° C to 13.5° C. Seasonal surface-to-bottom thermal gradients ranged from about 14° C to 18° C. The lowest bottom water temperatures were recorded in the summer (Lee and Mooers, 1977). This phenomenon is thought to reflect both the seasonal wind-induced upwelling of cooler waters over the slope and the increased volume transport of the Florida Current in the summer.

A 1989 report of a survey conducted near the preferred Palm Beach Harbor disposal site (4.5-mile site) found water temperatures ranging from 11.6° C at the bottom 535 ft (163 m) to 26.3° C at the surface. Surface temperatures ranged from 24.0 °C to 26.3° C and bottom temperatures ranged from 11.6° C (at 163 m) to 16.6° C (in 135 m). Slight thermoclines were observed between 66 ft (20 m) and 197 ft (60 m) depth in the survey area.

Data from a November 1986 survey in the vicinity of the preferred Port Everglades Harbor disposal site (4-mile site) indicated water temperatures of 11.2° C at 686 ft (209 m), 22.5° C at 384 ft (117 m), and 26.1° C at 14.4 ft (4.4 m) (raw data obtained from Chris McArthur, EPA). A thermocline is indicated between 384 ft (117 m) and 686 ft (209 m).

The 1998 EPA survey of the Port Everglades Harbor and Palm Beach Harbor alternative ODMDSs reported that water temperatures ranged from a high of 31° C to a low of 7° C at the bottom (300m). Surface temperatures ranged from 25° to 31° C. Bottom temperature ranged from 7° to 11° C. In general, offshore stations were warmer than nearshore stations. Thermoclines were observed between 20 and 50 m at most stations. Measured water temperatures at Palm Beach Harbor and Port Everglades Harbor sites are listed in Table 12 and average temperature profiles are shown in figures 4 and 5 in Appendix H.

3.8.2 Transmissivity

The 1998 EPA survey reported that the water at all stations was clear, as expected in Gulf Stream waters. Transmissivity was highest near the surface and relatively constant over the upper 140 m, ranged from 62-70%, then decreased below 150 m, reaching ranges of 42-65%.

Table 12. Average Water Temperatures at Palm Beach Harbor and Port Everglades Harbor Alternative Sites

Alternative ODMDSs		Time	Surface Water Temperature (^{0}C)	Deep Water Temperature (^{0}C)
Palm Beach Harbor	4.5-mile site	April	25.5	8 (at 185 m)
		May	26	8.2 (at 185 m)
	9-mile site	April	26	10 (at 200 m)
		May	26.8	7.5 (at 300 m)
		August	31	7 (at 300 m)
Port Everglades Harbor	4-mile site	April	25	7 (at 220 m)
		May	26.5	7.3 (at 225 m)
	7-mile site	April	26	8 (at 255 m)
		May	26.2	8.5 (at 270 m)

Source: EPA, 1999.

The 1998 EPA survey revealed that in Palm Beach Harbor alternative sites transmissivity was constant over the upper 150 m, (65.5-70.5%) then decreased below 150 m, reaching ranges of 51-69.5%. In Port Everglades Harbor alternative sites transmissivity was constant over the upper 140 m (66-70.5%), decreased below 140 m, reaching ranges of 46.5-70%. Average tranmissivity profiles are seen in figures 6 and 7 in Appendix H.

3.8.3 Salinity Gradients

Salinity in the Atlantic Ocean ranges from approximately 34 parts per thousand (‰) to 37‰ and averages about 36.5‰ (EPA, 1973). Subsurface core waters of the Florida Current generally range from 36.2‰ to 36.6‰ (CH2M Hill, 1985). Surface waters of the Florida Current occasionally exhibit reduced salinities as a result of the entrainment of fresh water from the Mississippi River system by the Gulf Loop Current during periods of increased river flow (U.S. Department of the Interior, 1977).

The density of seawater between Palm Beach Harbor and Miami, based on average salinity and temperature values, averages 1.024 grams per cubic centimeter (g/cc) (EPA, 1973). The average depth of the pycnocline varies seasonally from approximately 60 ft (18 m) in the summer to about 150 ft (46 m) in the winter (Marble and Mowell, 1971; in EPA, 1973). An EPA (1973) winter reconnaissance survey found the pycnocline off Miami at a depth of about 325 ft (99 m). Densities recorded during this EPA survey ranged from 1.0236 g/cc at the surface to 1.0260 gm/cc to a depth of 380 ft (116 m).

The 1989 report of the CSA survey conducted near the preferred disposal site (4.5-mile site) showed salinities in the range of 31.48‰ to 36.68‰. Salinities were highest in the top 98 ft (30 m) with salinities gradually decreasing as depth increased.

Salinities in the area of Port Everglades are likely to be similar to those in the Miami area. A January 1986 survey (CCI, 1986) of the Miami ODMDS vicinity recorded salinities ranging from 35.5‰ to 36.8‰.

The 1998 EPA survey also reported that salinities within the alternative sites were within the range of 34.8-36.5‰. Salinities were highest in the upper 100 m and tended to increase from the surface to a depth of about 20- 80 m, and then decrease as depth increased. Average salinity profiles are shown in figures 8 and 9 in Appendix H.

3.8.4 Dissolved Oxygen

The 1998 EPA survey found dissolved oxygen (DO) levels in the water column ranged from 3.3 mg/l to 6.5 mg/l. The dissolved oxygen trend in the alternative sites is tabulated in Table 13 and average DO profiles are shown in figures 10 and 11 in Appendix H.

Table 13. Average Dissolved Oxygen Trend at Palm Beach and Port Everglades Harbor Candidate Sites

<table>
<tr><th colspan="2">ODMDSs</th><th>Time</th><th>Upper DO (mg/l)</th><th>Lower DO (mg/l)</th></tr>
<tr><td rowspan="5">Palm Beach Harbor</td><td rowspan="2">4.5-mile site</td><td>April</td><td>6.0-6.5 (upper 50 m)</td><td>4.5 (at 150 m and remained between 4.5-4.7)</td></tr>
<tr><td>May</td><td>4.3-4.6 (upper 50 m)</td><td>3.5 (at 120 m and remained between 3.4-3.6)</td></tr>
<tr><td rowspan="3">9-mile site</td><td>April</td><td>5.8-6.6 (upper 100 m)</td><td>4.5 (at 160 m and remained same)</td></tr>
<tr><td>May</td><td>4.3-4.5 (upper 50 m)</td><td>3.5 (at 140 m and remained between 3.4-3.7)</td></tr>
<tr><td>August</td><td>3.8-4.5 (upper 50 m)</td><td>3.4 (at 120 m and remained between 3.3-3.9)</td></tr>
<tr><td rowspan="4">Port Everglades Harbor</td><td rowspan="2">4-mile site</td><td>April</td><td>5.9-6.4 (upper 50 m)</td><td>4.2 (at 130 m and remained between 4.2-4.8)</td></tr>
<tr><td>May</td><td>4.5-4.7 (upper 50 m)</td><td>3.4 (at 130 m and remained between 3.4-4.3)</td></tr>
<tr><td rowspan="2">7-mile site</td><td>April</td><td>5.7-6.3 (upper 50 m)</td><td>4.3 (at 150 m and remained between 4.3-4.7)</td></tr>
<tr><td>May</td><td>4.5-4.6 (upper 50 m)</td><td>3.4 (at 140 m and remained between 3.4-3.6)</td></tr>
</table>

Source: EPA, 1999.

3.8.5 Turbidity and Total Suspended Solids

Turbidity values recorded in the 1998 EPA survey ranged from 0.65 NTU to 2.5 NTU. Higher turbidity values were observed at the Port Everglades Harbor alternative ODMDSs (0.75-2.5 NTU) than at the Palm Beach Harbor ODMDS (0.65-1.2 NTU). Total suspended solids values ranged from 3 mg/l to 26 mg/l.

Figures 12 and 13 in Appendix H show a box plot of turbidity and total suspended solid concentrations at both project areas.

3.8.6 Trace Metals, Pesticides, and PCBs

Water quality data collected in the 1998 EPA survey generally displayed very low levels for trace metals, PCBs, and pesticides. Mercury, copper, cadmium, and lead were the trace metals selected for analysis. Cadmium and mercury levels were below the limits of detection (1.0 ppb and 0.2 ppb respectively). Lead levels ranged from 1.3 to 6.4 ppb, and copper levels ranged from below the detection limit (0.1 ppb) to 3.9 ppb. For comparison, federal marine water quality criteria are presented below:

Priority Pollutant	Criteria Maximum Concentration (ppb)	Criteria Continuous Criteria (ppb)
Mercury	1.8	0.94
Copper	4.8	3.1
Cadmium	42	9.3
Lead	210	8.1

All samples analyzed for pesticides and PCBs yielded results below the detection limits.

3.8.7 Total Petroleum Hydrocarbons

Total petroleum hydrocarbon (TPH) concentrations, as measured in the 1998 EPA survey, were higher than expected for the offshore candidate sites. Concentrations ranged from below detection limits (100 ppb) to 6300 ppb. Box plots for TPH are shown in figures 15 and 16 in Appendix H.

3.9 Sediment Quality

Benthos characteristics of the area were also surveyed by EPA in 1998. Granulometry, sediment chemistry, and biotal characteristics were analyzed in this survey. The results of this survey are summarized below and detailed in Appendix H.

3.9.1 Granulometry

Table 14 provides the grain size composition and mean grain size of samples collected at Port Everglades Harbor and Palm Beach Harbor alternative ODMDSs.

Table 14. Grain Size Composition and Mean Grain Size of Samples

<table>
<tr><th colspan="2">Alternative ODMDSs</th><th>Sand (%)</th><th>Silt and Clay (%)</th><th>Mean Grain Size (mm)</th></tr>
<tr><td rowspan="2">Palm Beach Harbor</td><td>4.5-mile site</td><td>70.0 (3 station avg.)</td><td>30.0 (3 station avg.)</td><td>0.14-0.175</td></tr>
<tr><td>9-mile site</td><td>79.6 (4 station avg.)</td><td>20.4 (4 station avg.)</td><td>0.18-0.185</td></tr>
<tr><td rowspan="2">Port Everglades Harbor</td><td>4-mile site</td><td>83.9 (3 stations avg.)</td><td>16.1(3 stations avg.)</td><td>0.18-0.19</td></tr>
<tr><td>7-mile site</td><td>85.7 (2 station avg.)</td><td>14.7 (2 station avg.)</td><td>0.22-0.23</td></tr>
</table>

Source: EPA, 1999.

3.9.2 Total Organic Carbon

The EPA 1998 survey did not give reliable TOC concentrations because of quality control issues. Previous sampling in the Palm Beach Harbor ODMDS reported results ranging from 0.3-0.6% (CSA, 1989), and in the Miami ODMDS area from 1.1-1.8% (CC, 1985).

3.9.3 Oil and Grease, TPHs, Pesticides and PCBs

Oil and grease, TPHs, and PCBs were all below detection limits in all samples collected during the survey.

3.9.4 Metals

Cadmium levels in survey samples ranged from below detection limits (0.1µg/g) to 0.15 µg/g. Copper levels were in the range of 1.8 to 4.8 µg/g in the survey area, with levels of 2.2 to 2.5 µg/g at both preferred ODMDSs (Figure 18, Appendix H). Lead levels ranged from 1.3 to 31.3 µg/g in the survey area, and 26 to 28µg/g at both preferred ODMDSs (Figure 19, Appendix H). Mercury was not detected (0.05 µg/g) at any station. The 1989 Palm Beach survey reported values of 0.03 to 0.05 µg/g for cadmium, 1.8 to 8.2 µg/g for lead and 0.01 to 0.3 µg/g for mercury (CSA, 1989).

3.9.5 Biotal Characteristics

Characterization of the benthos consists of macrofauna descriptions of the samples stations. Samples were collected in 1998 using various sampling techniques. The infaunal communities were described by a number of community parameters such as composition, dominant taxa, density, and species richness.

Overall, macrofaunal samples were dominated in numbers by annelids and arthropods. All alternative sites were similar in that they had a similar number of taxa dominated by the same major taxonomic groups. Benthic biotal characteristics are discussed further in Sections 3.5.3 to 3.5.5.

3.10 Air Quality

In response to Clean Air Act (CAA), EPA has established National Ambient Air Quality Standards (NAAQS) for the protection of human health and welfare. The NAAQS represent maximum levels of pollutants and exposure periods that pose no significant treat to human health or welfare. Air quality within the project area is good due to very little emission activity and the presence of offshore breezes. Both Palm Beach and Broward counties are classified as attainment areas for all NAAQS.

3.11 Noise

Noise is defined as "unwanted sound" and in the context of protecting public health and welfare, implies potential effects on people and, in general, the environment. Noise is one of the major concerns associated with dredging-related activities. Ambient noise levels at all the alternative ocean disposal sites is expected to be very low. Sound in the open ocean is generated by a broad range of sources, both natural and anthropogenic.

For noise above the ocean surface, ambient noise level is highly dependent on wind velocity (Bolt *et al*., 2003). Bolt *et al*. (2003) reported ambient sound levels ranging from 15 dB for little to no wind to 50 dB for winds up to 9 meters per second.

For noise beneath the ocean surface, natural geophysical sources of sound include wind-generated waves, earthquakes, precipitation, and cracking ice. Rain can raise noise levels by up to 35 dB across a range of frequencies. Natural biological sounds include whale songs, dolphin clicks, and fish vocalizations. Anthropogenic sounds are generated by a variety of activities, including commercial shipping, geophysical surveys, oil drilling and production, dredging and construction, sonar systems, and oceanographic research. Ambient noise ranges from 20 to 90 dB re 1μPa over a frequency range of 1-100,000 Hz. (NRC, 2003)

3.12 Aesthetic Resources

Aesthetic resources are natural resources, landform, vegetation, and man-made structures in the environment that generate one or more sensory reactions and evaluations by the observer, with particular emphasis on pleasurable response.

The alternative ODMDSs are located on the continental slope of the Atlantic Ocean. The open ocean is the only aesthetic resource in the area.

3.13 Recreation Resources

The project areas are located near the coastal waters of Broward and Palm Beach counties. These waters are used for swimming, skiing, sailing, boating, surfing, skin diving, and SCUBA diving. The alternative ODMDSs are too deep or too distant from shore for all of these activities except sailing.

3.13.1 Commercial and Recreational Fisheries

The alternative ODMDSs do not support significant recreational and commercial fisheries resources. Demersal fishes depend on invertebrates in sediments for forage. Local sediment alterations could affect fish populations. While pelagic fish may utilize the area, the heaviest fishing pressure along the southeastern coast of Florida is concentrated at the inshore natural and artificial reefs. In general, movement of nekton into the estuaries occurs mainly from January to June, while migration back into the Atlantic Ocean typically occurs from August to December (Table 15).

Commercial and recreational fishing activity is concentrated in inshore and nearshore waters or at offshore natural and artificial reefs. All considered alternative sites are located at least 2.3 nmi (4.3 km) from the natural or artificial reefs. All considered alternative sites are located within reported habitat (175 to 300 meters water depth) for the Golden Tilefish (Parker and Mays, 1998). EPA does not believe the Palm Beach Harbor preferred ODMDS provides the necessary malleable substrate from which the tilefish can construct shelter and that any impact to tilefish habitat at the Port Everglades Harbor preferred ODMDS will be minor (See Appendix I). Therefore, disposal activities are not expected to interfere with fishing activities.

Table 15. Migratory Behavior of Some Coastal Nekton Common to Coastal Florida

Month of Occurrence	Species Moving into Estuaries (or Nearshore Zone)	Species Moving from Estuaries
January	Southern hake, red drum (peak)	Menhaden, spadefish
February	Stingray, brown shrimp (post larvae)	
March	Gulf killifish, spot, cutlassfish, hogchoker, butterfish, rough silverside, flounder, tonguefish	Blue catfish, sheepshead minnow, longnose killifish
April	Gafftopsail and sea catfish, bluefish, bumper, sand seatrout, southern kingfish, skipjack, herring (in and out same month), adult croaker, black drum (peak), pinfish, Atlantic threadfin, toadfish, midshipman	Bighead searobin
May	Striped anchovy, lizardfish, sardine, Spanish mackerel, white shrimp (post larvae)	Menhaden, southern hake
June	Needlefish, pompano, crevalle jack, leatherjacket, Atlantic moonfish	Butterfish
July	Ladyfish, lookdown	
August		Ladyfish, Atlantic threadfin
September		Adult croaker, rough silverside
October	Menhaden, sheepshead minnow, bighead searobin	Sardine, bluefish, leatherjacket, Atlantic moonfish, sand seatrout, cutlassfish, Spanish mackerel
November	Blue catfish, juvenile croaker	Striped anchovy, gafftopsail catfish, needlefish, pompano, crevalle jack, bumper, lookdown, pinfish, tonguefish, toadfish, midshipman, white shrimp (juveniles)
December	Longnose killifish	Stingray, lizardfish, spot, southern kingfish, flounder, hogchoker

Source: Schomer and Drew, 1982.

Palm Beach Harbor

There are several documented artificial reefs located in the vicinity of the alternative sites for Palm Beach Harbor (Palm Beach County, undated). Table 16 provides amplifying information on artificial reefs in Palm Beach County, and Figure 6 provides geographic locations of the reefs with respect to the project area (Figure 6 also includes the location of the *Oculina* reef approximately 1.7 nmi (3.2 km) west of the preferred site discussed in Section 3.4). One cluster of two artificial reef sites is located 2.0 nmi (3.7 km) west of the western edge of the preferred (4.5-mile) site. Another cluster of four sites is located 3 nmi (5.5 km) west of the western edge. Two additional clusters, with six sites and five sites, respectively lie 4 nmi (7.4 km) and 4.4 nmi (8.15 km) west of the western edge (Table 16 and Figure 6).

Port Everglades Harbor

A number of documented artificial reefs are located in the vicinity of the alternative sites for Port Everglades Harbor (Palm Beach and Broward counties, undated). Table 17 provides amplifying information on artificial reefs in Broward County and Figure 7 provides geographic locations of the reefs with respect to the project area. One cluster of 17 structures is located approximately 2.25 nmi (14.2 km) northwest of the preferred (4-mile) site. Another cluster of three structures is located 2.8 mi (4.5 km) southwest of the southwestern edge of the preferred site. One structure is located approximately 3 nmi (5.5 km) west of the southwest ridge of the 7-mile candidate site (Table 17 and Figure 7).

3.13.2 Other Recreation

Broward and Palm Beach counties waters support a wide variety of recreational activities other than fishing. Coastal waters are also used for swimming, skiing, sailing, boating, surfing, skin diving, and SCUBA diving. Few of these activities occur in, and none is restricted to, the proposed ODMDSs.

3.14 Navigation

The preferred Palm Beach Harbor and Port Everglades Harbor ODMDSs are located to the northeast and 4.5 nmi (8.3 km) and 4.0 nmi (7.4 km) seaward of the entrance channels to Palm Beach Harbor and Port Everglades Harbor, respectively. The candidate Palm Beach Harbor and Port Everglades Harbor ODMDSs are located to the northeast and 9 nmi (16.7 km) and 7 nmi (13.7 km) seaward of the entrance channels to their respective channels. While there are no designated shipping lanes beyond the entrance channel, the general areas experience heavy commercial shipping traffic.

3.15 Military Usage

While the Atlantic Ocean off Palm Beach Harbor and Port Everglades Harbor may be used by the United States armed forces for training, testing, and research activities, the alternative ODMDSs do not lie within any designated fleet operating area as identified by the Department of the Interior (DOI) (1977). The preferred Port Everglades Harbor ODMDS is located approximately 1.5 miles north of the northern boundary of the Navy's South Florida Testing Facility (SFTF).

Table 16. Artificial Reef Locations in the Vicinity of the Proposed Palm Beach Harbor ODMDS

Name	Latitude	Longitude	Depth (ft)	Distance to (4.5-Mile) Preferred Site (mi)	Distance to (9-Mile) Candidate Site (mi)	Composition
Jupiter Inlet						
Ratican	26°58.96’N	80°00.89’W	90	14.5	16.3	Sailboat
Esso Bonaire III	26°57.85’N	80°00.48’W	90	13.2	14.9	Tanker
Miss Jenny	26°57.83’N	80°00.44’W	90	13.3	14.9	Barge
Jupiter Concrete	26°58.79’N	80°00.45’W	90	14.3	15.8	Concrete
Barge MG111	26°58.67’N	80°01.49’W	60	14.5	15.7	Barge, concrete
Tug Boat Reef	26°58.56’N	80°00.98’W	70	14.1	15.8	Tug boats (3)
Jupiter/Carlin Reef	26°54.83’N	80°03.54’W	14	11.5	14.5	Rock
Diamondhead Radnor	26°54.80’N	80°03.44’W	16	10.8	14.7	Rock
Sea Mist II	26°57.49’N	79°59.11’W	210	11.7	14.3	Freighter
Barge Conrad	26°54.75’N	80°03.44’W	18	10.8	14.7	Barge
Lake Worth Inlet						
Classic Barge P1	26°47.42’N	79°59.10’W	275	2.6	6.7	Barge
Classic Barge P6	26°47.30’N	79°59.38’W	235	2.9	7.0	Barge
Princess Anne	26°47.59’N	80°00.22’W	98	3.8	7.8	Ferry
Playground	26°47.37’N	79°59.79’W	130-150	3.3	7.6	Concrete
Spearman's Barge	26°47.59’N	80°00.35’W	70	4.0	8.0	Barge
Murphy's Barge II	26°48.13’N	80°01.10’W	75	4.8	8.8	Barge
Research Team Reef	26°47.36’N	80°01.00’W	70	4.6	8.7	Barges, concrete
Amaryllis	26°47.30’N	80°00.96’W	80	4.6	8.7	Freighter
Mizpah/PC1174	26°47.18’N	80°00.96’W	80	4.5	8.7	Vessels
Habitat Corridors	Connects Research Team Reef, Amaryllis, and Mizpah/PC1174		80	---	---	Rock

Table 16 (cont'd). Artificial Reef Locations in the Vicinity of the Proposed Palm Beach Harbor ODMDS

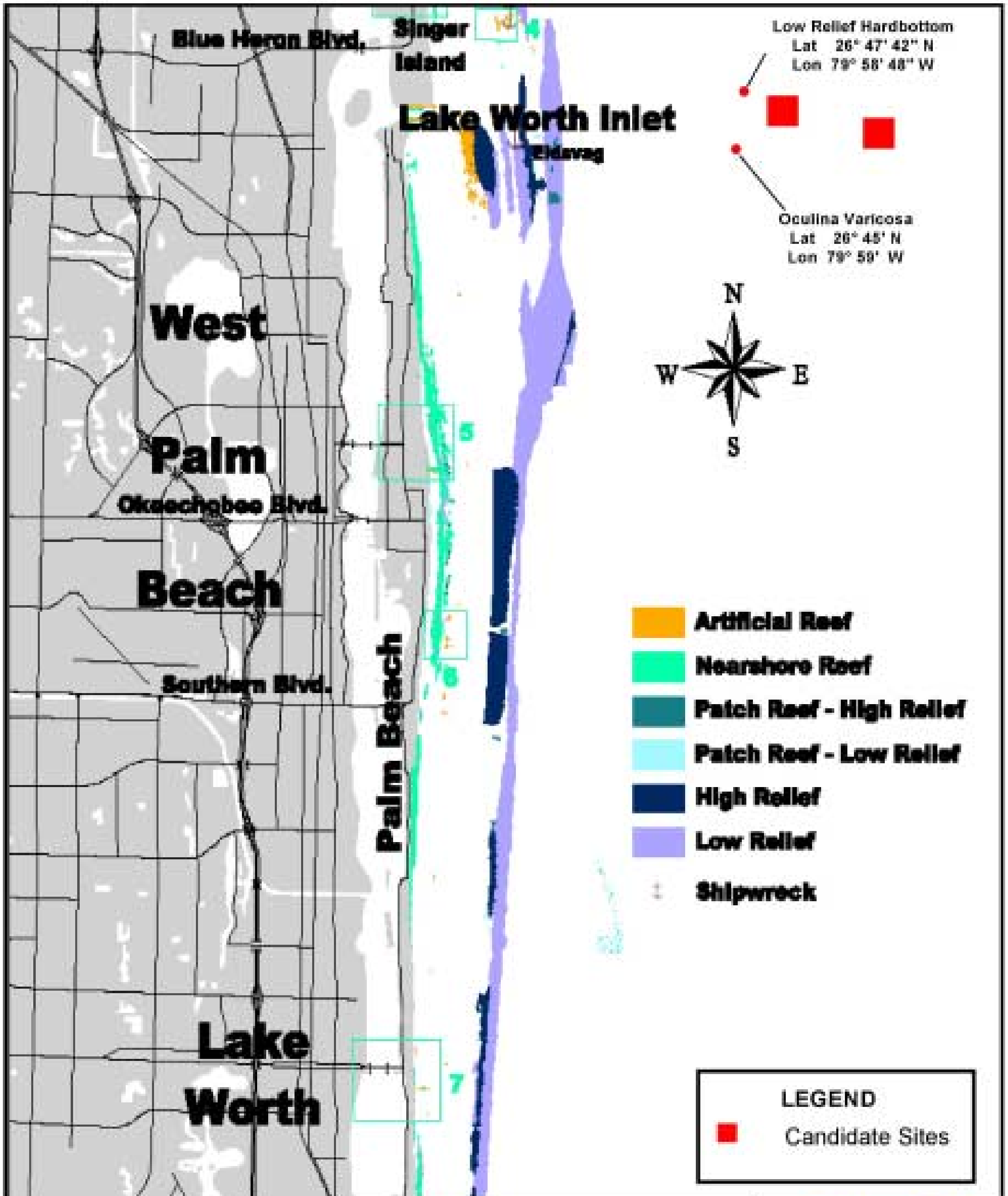
Name	Latitude	Longitude	Depth (ft)	Distance to (4.5-Mile) Preferred Site (mi)	Distance to (9-Mile) Candidate Site (mi)	Composition
EIDSVAG/Barge/ Rolls Royce	26°46.02'N	80°00.50'W	80	4.2	8.9	Vessels, car
Cross Current Reef	26°45.69'N	80°01.26'W	60	5.1	9.1	Barge, rock
TSO Paradise	26°45.79'N	80°01.29'W	60	5.1	9.1	Yacht
Tri-County Concrete	26°45.78'N	80°01.29'W	60	5.1	9.1	Concrete
PEP Reef	26°40.72'N	80°01.73'W	25-27	9.0	11.9	Modules
Kreusler Park	26°37.00'N	80°02.00'W	10-12	12.7	15.1	Concrete, rock
M/V Jed Carrier	26°47.28'N	79°59.54'W	N/A	3.1	7.2	Ship
Royal Park Bridge	26°47.68'N	80°01.05'W	75	4.2	9.0	Concrete
Shasha Boekanier	26°45.05'N	80°00.59'W	88	4.4	8.7	Vessel
St. Jacques	26°45.07'N	80°00.61'W	87	4.4	8.7	Vessel
Thozina	26°45.10'N	80°00.50'W	88	4.4	8.7	Vessel
Gilbert Sea	26°45.19'N	80°00.61'W	89	4.4	8.7	Vessel
Lake Worth Lagoon						
Sugar Sands Reef	26°47.61'N	80°02.69'W	23	6.3	10.4	Modules, rock
Rybovich Reef	26°45.03'N	80°02.59'W	23	6.6	10.5	Modules, rock
Boynton Inlet Reef	26°32.65'N	80°02.78'W	14	17.6	19.7	Rock
Lantana's Sportsman	26°35.10'N	80°02.80'W	9-13	14.5	15.8	Concrete
Boynton Beach Inlet						
Boynton Kiwanis Miller Lite Reef	26°33.24'N	80°01.06'W	200	16.4	18.1	Freighter
Becks	26°28.87'N	80°02.35'W	80	21.7	23.1	Freighter
Budweiser Bar	26°28.75'N	80°02.31'W	85	21.8	23.3	Freighter

Table 16 (cont'd). Artificial Reef Locations in the Vicinity of the Proposed Palm Beach Harbor ODMDS

Name	Latitude	Longitude	Depth (ft)	Distance to (4.5-Mile) Preferred Site (mi)	Distance to (9-Mile) Candidate Site (mi)	Composition
Swordfish	26°28.70'N	80°02.33'W	80	21.8	23.4	Treasure Hunter
Genesis Reef	26°28.65'N	80°02.40'W	80	21.8	23.4	Concrete
Boynton Corridors	---	---	80	---	---	Rock
Ocean Ridge North	26°31.97'N	80°02.62'W	18	21.9	20.1	Concrete
Ocean Ridge South	26°31.88'N	80°02.64'W	21	21.9	20.2	Concrete
Gulfstream North	26°30.15'N	80°03.03'W	11	20.4	22.1	Rock
Gulfstream South	26°30.03'N	80°03.05'W	11	20.5	22.1	Rock
M/V Castor	26°28.80'N	80°02.20'W	120	21.8	23.2	Cargo ship
Boca Raton Inlet						
CSA Modules	26°21.97'N	80°03.30'W	60	29.8	30.9	Concrete
Hydro Atlantic	26°19.49'N	80°03.04'W	165	32.1	33.5	Dredge
Sea Emperor	26°19.32'N	80°03.54'W	65	32.5	33.6	Barge, concrete
United Caribbean	26°19.27'N	80°03.54'W	72	32.5	33.6	Cargo ship
Noula Express	26°19.28'N	80°03.46'W	70	32.7	33.9	Freighter
Ancient Mariner	26°18.11'N	80°03.74'W	70	34.1	35.2	CG Cutter
Copenhagen[(1)]	26°12.35'N	80°05.11'W	16-31	40.9	42.0	Steamship

Notes: (1) State underwater archaeological preserve.

Source: Palm Beach County, Department of Environmental Resources Management, Artificial Reef Program Brochure, n.d; Palm Beach County website, 2004.



ARTIFICIAL REEF STRUCTURES IN
THE VICINITY OF PALM BEACH HARBOR ODMDS
Palm Beach/ Port Everglades FEIS
Palm Beach and Broward Counties, Florida
Palm Beach County (1998)

GEC
Gulf Engineers & Consultants, Inc.

Figure: 6
Date: June 2004
Scale: N/A
Source: GEC/PALM BEACH

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Table 17. Artificial Reef Locations in the Vicinity of the Proposed Port Everglades Harbor ODMDS

Name	Latitude	Longitude	Loran C	Depth (ft)	Distance to (4-Mile) Preferred Site (mi)	Distance to (7-Mile) Candidate Site (mi)	Composition
Houseboat	26°08’51”N	80°05’00”W	---	95	4.2	6.9	Vessels
Bud Krohn	26°08’51”N	80°05’00”W	---	440	4.2	6.9	Freighter
Trio Bravo	26°08’51”N	80°05’00”W	---	145	4.2	6.9	Tug
FL League of Anglers	26°08’51”N	80°05’00”W	---	388	4.2	6.9	Minesweeper
Rebel	26°08’51”N	80°05’00”W	---	110	4.2	6.9	Freighter
Jim Atria	26°08’51”N	80°05’00”W	---	110	4.2	6.9	Freighter
Robert Edmister	26°08’51”N	80°05’00”W	---	70	4.2	6.9	Cutter
River Bend	26°08’51”N	80°05’00”W	---	98	4.2	6.9	Vessels
Bill Boyd Reef	26°08’51”N	80°05’00”W	---	265	4.2	6.9	Freighter
Hog Heaven	26°08’51”N	80°05’00”W	---	64	4.2	6.9	Barges, lighthouse
Jay Scutti	26°08’51”N	80°05’00”W	---	67	4.2	6.9	Schooner
Qualmann Barge	26°08’51”N	80°05’00”W	---	145	4.2	6.9	Barge
Osborne	26°08’51”N	80°05’00”W	---	73	4.2	6.9	Barge
Grouper Grotto	26°08’51”N	80°05’00”W	---	150	4.2	6.9	Tanks, pipes, concrete
Powell Barge, DB 24	26°08’51”N	80°05’00”W	---	314	4.2	6.9	Barge, concrete
Mariott Reef	26°08’51”N	80°05’00”W	---	71	4.2	6.9	Airplane
Mercedes	26°08’51”N	80°05’00”W	---	97	4.2	6.9	Freighter
Tracor/Navy Drydock	26°06’48”N	80°04’10”W	---	210	2.8	6.0	Vessels, drydock
Powell Barges	26°06’48”N	80°04’10”W	---	270	2.8	6.0	Barges
TE AMO	26°06’48”N	80°04’10”W	---	215	2.8	6.0	Vessel
Erojacks	26°06’43”N	80°05’43”W	---	14	4.4	7.5	Concrete erojacks
Berry Patch	26°18’07”N	80°03’45”W	---	65	13.0	13.4	Vessels (4)
Deerfield Pier	---	---	---	67	---	---	Unknown
Hydro Atlantic	26°19’30”N	80°03’02”W	---	184	14.7	14.5	Dredge

Table 17 (cont'd). Artificial Reef Locations in the Vicinity of the Proposed Port Everglades Harbor ODMDS

Name	Latitude	Longitude	Loran C	Depth (ft)	Distance to (4-Mile) Preferred Site (mi)	Distance to (7-Mile) Candidate Site (mi)	Composition
Noula Express	26°19'16"N	80°03'27"W	---	71	14.4	14.5	Vessel
Pennels Reef	26°19'11"N	80°04'05"W	---	30	14.4	14.7	Dredge Pontoon
Corey and Chris	26°13'52"N	80°03'26"W	---	244	14.4	9.0	Dredge Trident
Rodeo Divers Reef	26°13'51"N	80°04'02"W	---	78	8.3	14.8	Vessels
Wildlife Forever	26°14'03"N	80°03'40"W	---	156	8.4	9.4	Dredge
Buddy Merrit	26°14'09"N	80°03'22"W	---	414	8.5	9.2	Vessel Cradles
Caicos Express	26°12'30"N	80°03'40"W	---	240	6.8	7.9	Vessel
Cap. Dan Garsey	26°13'51"N	80°03'58"W	---	109	8.3	14.7	Vessel
Chevron Rodeo	---	---	14271.3 x 62097.1	170	---	---	Fuel Tanks
Fishamerica	26°13'38"N	80°03'54"W	---	115	8.0	9.0	Vessel
Guy Harvey	26°12'39"N	80°03'58"W	---	135	7.0	8.2	Vessel
Imor	26°13'03"N	80°03'45"W	---	165	7.3	8.3	Vessel
Johnny Morris Offshore Angler	26°14'23"N	80°03'25"W	---	215	8.7	9.5	Vessel
Kornahrens	26°12'30"N	80°03'11"W	---	140	6.6	7.5	Netting
Lowrance	26°13'12"N	80°03'38"W	---	200	7.5	8.6	Vessel
Mako	---	---	14272.0 x 62096.2	240	---	---	Hull Molds
Mariner I	26°14'25"N	80°03'30"W	---	108	8.8	9.5	Vessel
Mariner II	26°14'07"N	80°03'48"W	---	110	8.6	9.3	Vessel and Barge
Miller Lite	26°14'12"N	80°03'40"W	---	155	8.6	9.5	Vessel
Papa's Reef	26°14'06"N	80°03'23"W	---	260	8.4	9.2	Vessel
Renegade	26°13'22"N	80°03'37"W	---	190	7.6	8.5	Vessel
Rodeo 25"	26°13'53"N	80°03'49"W	---	122	8.2	9.1	Vessel

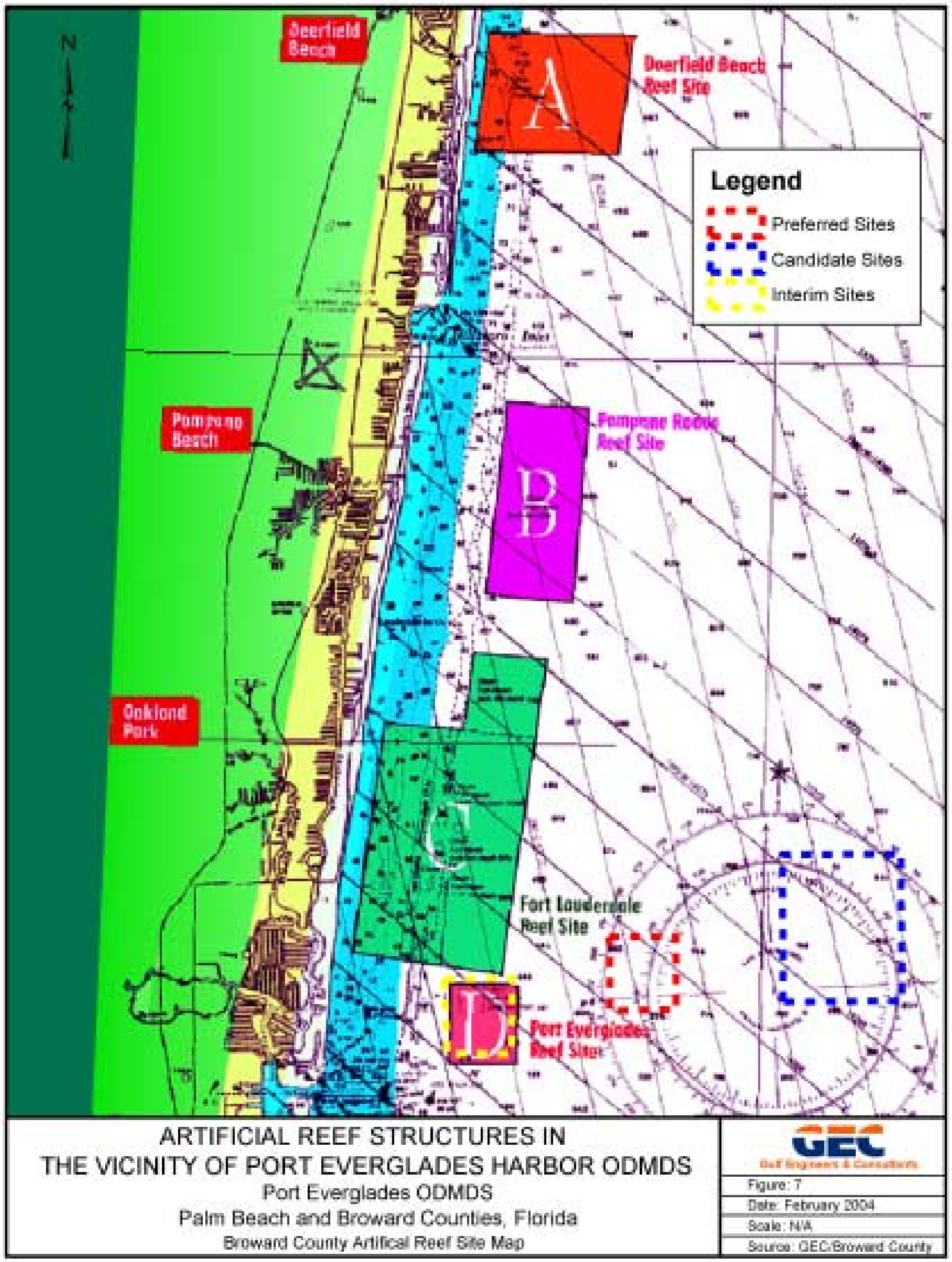
Table 17 (cont'd). Artificial Reef Locations in the Vicinity of the Proposed Port Everglades Harbor ODMDS

Name	Latitude	Longitude	Loran C	Depth (ft)	Distance to (4-Mile) Preferred Site (mi)	Distance to (7-Mile) Candidate Site (mi)	Composition
Ronald B. Johnston	26°13'53"N	80°03'27"W	---	122	8.2	8.9	Vessel
Tote Machines	---	---	14271.6 x 62096.4	200	---	---	Debris
Bruce Mueller	26°10'07"N	80°04'42"W	---	45	4.8	7.1	Vessel
Chevron 1"	26°07'24"N	80°04'33"W	---	73	4.8	6.3	Vessel
Chevron 3"	26°08'06"N	80°04'06"W	---	190	3.0	5.8	Vessel
Chris Coffman Reefball	26°07'30"N	80°04'24"W	---	22	3.1	6.0	Reefballs (11)
Corky M.	26°10'05"N	80°04'43"W	---	65	4.9	7.6	Vessel
Eagle Scout Reef	26°07'30"N	80°05'53"W	---	22	4.6	7.6	Reedfballs (25)
Great Lakes	---	---	14263.9 x 62105.1	170	---	---	Vessel
Harbor Town	---	---	14265.2 x 62106.3	70	---	---	Vessel
Bulk Trader	26°08'36"N	80°03'50"W	---	313	7.8	8.4	Vessel
Eben-Ezer 2	26°00'24"N	80°05'35"W	---	69	8.0	10.25	Vessel
Merci Jesus	26°09'38"N	80°04'45"W	---	72	4.6	6.9	Vessel
Moonshot	---	---	---	70	---	---	Vessel
Paul Sherman	---	---	14264.8 x 62106.6	70	---	---	Vessel
Peter B. McAllister	26°10'09"N	80°04'43"W	---	69	5.5	7.1	Vessel
Reef Balls (Deep)	26°07'48"N	80°04'25"W	---	144	3.2	6.2	Prefab Concrete
Reef Balls (Shallow)	26°07'31"N	80°04'25"W	---	23	3.1	6.1	Prefab Concrete
Reuben Reef	---	---	14262.5 x 62109.0	70	---	---	Vessels
Spaghetti Barge	---	---	14263.7 x 62106.7	105	---	---	Vessel

Table 17 (cont'd). Artificial Reef Locations in the Vicinity of the Proposed Port Everglades Harbor ODMDS

Name	Latitude	Longitude	Loran C	Depth (ft)	Distance to (4-Mile) Preferred Site (mi)	Distance to (7-Mile) Candidate Site (mi)	Composition
Wendy Rossheim	26°09'11"N	80°04'49"W	---	65	4.3	6.8	Vessel
NSWC	26°10'30"N	80°03'13"W	---	150	4.4	6.0	Cable Spools
AFDL-8	---	---	14261.2 x 62107.4	220	---	---	Drydock
Chris Craft Molds	---	---	14261.4 x 62107.2	70	---	---	Molds
FAD	---	---	14262.0 x 62107.2	110	---	---	Midwater Kites
Joe's Nightmare	26°06'48"N	80°04'13"W	---	217	2.8	5.9	Barge
Marriot	---	---	14261.4 x 62109.8	71	---	---	Airplane
Monomy	---	---	14263.2 x 62107.5	60	---	---	Vessel
NSWC Sea Con Reef	26°00'36"N	80°05'37"W	---	74	8.5	11.1	Acoustic Arrays (2) & Concrete
Port Everglades Reef	26°06'45"N	80°04'02"W	---	150	2.6	5.7	Concrete Piers
Capt. DeDe	26°00'34"N	80°05'36"W	---	75	8.6	11.0	Vessel
Cruz del Sur	25°58'10"N	80°04'38"W	---	230	10.7	12.5	Vessel
Curry Reef	26°00'39"N	80°05'36"W	---	75	8.4	11.0	Barge & Crane Boom
Donald G. McAllister	26°00'33"N	80°05'34"W	---	75	8.6	11.0	Vessel
Emmi Boggs	26°00'36"N	80°05'37"W	---	75	8.5	11.0	LCM
Hollywood Reef	26°07'30"N	80°05'53"W	---	73	4.6	7.6	Reefballs, Pipe, & Barges
Tenneco (Deep)	25°58'53"N	80°04'48"W	---	190	10.0	11.9	Oil Rig Legs
Tenneco (Shallow)	25°58'57"N	80°05'06"W	---	105	10.0	11.9	Oil Rig Decks

Source: Pybas, 1991; Broward County website, 2003.


N
Deerfield Beach
Pompano Beach
Oakland Park
A
Deerfield Beach Reef Site
Legend
Preferred Sites
Candidate Sites
Interim Sites
B
Pompano Beach Reef Site
C
Fort Lauderdale Reef Site
D
Port Everglades Reef Site
ARTIFICIAL REEF STRUCTURES IN
THE VICINITY OF PORT EVERGLADES HARBOR ODMDS
Port Everglades ODMDS
Palm Beach and Broward Counties, Florida
Broward County Artifical Reef Site Map
GEC
Figure: 7
Date: February 2004
Scale: N/A
Source: GEC/Broward County

3.15.1 South Florida Testing Facility

Located on the south side of the Port Everglades inlet in Dania, Florida, the SFTF has housed an active, continuously operating Navy range for over 40 years (Figure 8). The SFTF was placed under the administration of the Naval Surface Warfare Center, Carderock Division in 1994. The SFTF allows the monitoring of surface ship, submarine, and remote vehicle signatures in the nearshore environment. Multiple fixed in-water electromagnetic and acoustic measurement sites at 10, 20, and 200 m are controlled from a secure range house. The range encompasses the Navy's only shallow and deep magnetic research and development ranges, including submerged operations.

The SFTF is currently the centerpiece of the newly formed South Florida Ocean Measurement Center (SFOMC). The SFOMC offers a means to evaluate mine detection, countermeasures and mine response; perform acoustic measurements; and acquire radar cross section and infrared signatures. The SFOMC is the only ship, submarine, and mine-effectiveness test range with simultaneous air, surface, and subsurface tracking capability.

3.15.2 Existing Features and Planned Expansions

The SFOMC is divided into the following ranges: 60-ft area, 600-ft area, and mine fields. Existing structures and planned expansions for each of the ranges are discussed below.

60-Foot Area

Existing features in the 60-ft area include a shallow water acoustic range (SWAR), a shallow water electromagnetic range (SWER), the Port Everglades ADCP, and a forward area combined degaussing and acoustic range (FACDAR- in 30 ft).

Planned expansion in the 60-ft area includes the installation of an AUV docking station (power and data transmission), a modem system with transmitter and 32-channel receive array with 40 kHz window up to 250 kHz, a Cyclesonde Autonomous Profiler to measure currents and buoyancy, a five head ADCP, an ambient noise sonar array, and two environmental arrays (measuring current, temperature, conductivity, and salinity versus depth).

600-Foot Area

Existing features in the 600-ft area include a submarine tracking system, navigation and communication systems, an intermediate depth electromagnetic array (IDEA), and a deep ADCP.

Planned expansion in the 600-ft area calls for the emplacement of three 32-element acoustic arrays (one oriented vertically and two horizontally) and two environmental arrays (measuring current, temperature, conductivity, and salinity versus depth).

Mine Fields

The mine fields range contains a deep mixed submarine mine field. Planned expansion in this area includes the addition of a bottom and buried field and a shallow suspended field.

EXISTING SFTF RANGE AND PROPOSED SFOMC EXPANSION

Palm Beach Harbor ODMDS

Palm Beach and Broward Counties, Florida

USGS 1:250 Series West Palm Beach (1987) and Miami (1988) Quadrangles and NOAA Bahamas (1980) and Bimini (1926) Bathymetric Maps

Other Planned Expansions

In addition to the planned expansion measures discussed above, the SFOMC is planning the addition of a number of other features in the Port Everglades area. Additional expansion plans include the installation of a shore side Ocean Current Surface Radar (OSCAR) apparatus three 32-channel acoustic arrays with thermisters (NRL, UM, WHOI), a 10-channel thermister array (UM), a Miami Sound Machine (UM), an LWAD Assets-Bathymetry, geo-acoustic survey, NRL high-frequency imaging sonar, autonomous undersea vehicles (AUVs) (ONR/FAU) or with following capabilities: low- and high-frequency sidescan sonar, multi-beam passive sonar arrays, CTD, ADCP, sub-bottom sonar, turbidity censor, video camera, acoustic imager, and buried object imager (towed).

3.16 Mineral Resources

The Minerals Management Service (MMS) has not conducted any mineral resource surveys in the waters offshore Palm Beach and Broward counties. There are no known recoverable mineral resources in the vicinity of the proposed Palm Beach Harbor and Port Everglades Harbor ODMDSs. The MMS has not identified any potential sand sources for beach nourishment in the area.

3.17 Other Usage

3.17.1 Subsea Cables

The ocean bottom in the vicinity of the continental shelf may sometimes contain communication cables or gas pipelines. Data for communication cables are not determinable within the project areas according to the Office of Public Affairs (OPA). Charts obtained from AT&T provide the locations of existing telephone cables offshore of Palm Beach and Broward counties as of 30 August 1996. The charts indicate that two telephone cables may intersect the preferred and candidate sites for the Palm Beach Harbor ODMDS. The cables, Florico-1 (N-S) and Florico-1 (S-N), are listed as out of service on the chart. No existing cables that may intersect that proposed sites for Port Everglades Harbor were noted on the chart. The Florida Department of Environmental Protection (FDEP) Southeast Office was contacted regarding fiber optic cables offshore of Pam Beach and Broward counties. FDEP provided the following information regarding permitted fiber optic cables offshore of the counties:

Palm Beach County Landings	Broward County Landings
West Palm Beach (AT&T)	Port Everglades (U.S. Navy)
Delray Beach (Florida Teleport)	Hollywood (AT&T)
Boca Raton (BICS)	
Boca Raton (Tyco/Emergia/Atlantic)	

FDEP further stated that undisclosed cables might potentially exist from the Navy.

Detailed maps of fiber optic cable layouts were not available for the above locations. However, a general state map of offshore fiber optic cables provided by FDEP indicated that the cables extend eastward for all the above locations. Based on this information, although the fiber optic cables at West Palm Beach and Port Everglades may lie in close proximity to the proposed Palm Beach and Port Everglades Harbor sites, respectively, it is unlikely that these cables intersect the proposed sites. No known instances of damage to underwater cables occurring as a result of offshore dredged material disposal were found. Consequently, it is unlikely that any impacts to underwater cables in the vicinity of the project area will occur as a result of implementation of the proposed project. Information on existing gas pipelines was not determinable. Existing pipelines are considered unlikely to exist in the project areas; however, the proposed Ocean Express and Calypso Pipeline Projects calls for the emplacement of 24-inch natural gas pipelines between Port Everglades and the Bahamas.

3.17.2 AES Ocean Express Pipeline Project

In February 2002, AES Ocean Express LLC submitted an application to lay a 54.3-mile, 24-inch pipeline from a receipt point on the Economic Exclusion Zone between the United States and the Bahamas to delivery points in Broward County, Florida, together with certain ancillary facilities. Approximately 48 miles of this pipeline will be laid in the Atlantic Ocean off Florida's east coast. The remaining 6.3 miles would extend west from a shoreline entry point east of Dania, Florida, and end at proposed interconnections with Florida Gas Transmission Company and Florida Power and Light Company systems. The proposed pipeline would transport up to 842 million standard cubic feet of natural gas into Florida per day. Although specific geospatial coordinates of the AES Ocean Express Pipeline are not readily available, comparison of the pipeline project's map layout with that of the proposed Port Everglades Harbor ODMDS indicates that the proposed pipeline route appears to passes no closer than approximately 4 nmi south of the preferred (4-mile) site.

3.17.3 Tractebel Calypso Pipeline Project

Tractebel Calypso LLC has also proposed construction of a pipeline to transport natural gas from the Bahamas to South Florida. The application for the pipeline was first filed in July 2001. An application for the pipeline was originally filed by Enron to lay the Calypso pipeline, and was assumed by Tractebel in 2002. This 24-inch pipeline would begin at a proposed regasification plant near Freeport, Bahamas and be laid 89.9 miles to Port Everglades in Broward County Florida, where it will connect with the proposed Tractebel Calypso onshore pipeline segment. Approximately 36 miles of this pipeline would extend from the Economic Exclusion Zone to the coast of Florida. The proposed pipeline is 90 miles in total length and will transport up to 832 million standard cubic feet of natural gas per day. Directional drilling will be utilized at the onshore approaches to the pipeline to minimize environmental effects. Although specific geospatial coordinates of the AES Tractebel Calypso Pipeline are not readily available, comparison of the pipeline project's map layout with that of the proposed Port Everglades Harbor ODMDS indicates that the proposed pipeline route is in close proximity to the preferred and candidate sites for the Port Everglades Harbor ODMDS. EPA expressed concern in a letter dated 17 September 2003 regarding a conflict between the proposed pipeline alignment and the proposed Port Everglades Harbor sites. The Federal Energy Commission, in its response to this letter, stated that the proposed Calypso pipeline alignment would avoid both the preferred and the candidate sites for the Port Everglades Harbor ODMDS.

3.17.4 El Paso Seafarer Pipeline Project

Florida Power and Light Group Resources and El Paso Corporation signed an agreement in April 2004 for capacity on the proposed El Paso Seafarer Pipeline System. The proposed pipeline will have a total length of 160 miles and a diameter of 26 inches. The system as planned will transport natural gas for the proposed High Rock liquefied natural gas regasification facility in the Bahamas to south Florida. Landfall will be at Riviera Beach in Palm Beach County, from which the pipeline will extend 42 miles to an existing gas pipeline and a power generation plant. A pipeline capacity of

800,000 dekatherms per day of natural gas is planned. Transportation service is estimated to begin in 2008, when the pipeline and the proposed Bahamas facility are scheduled to be completed. Although specific geospatial coordinates of the El Paso Seafarer Pipeline are not readily available, a comparison of the pipeline project's map layout with that of the proposed Palm Beach Harbor ODMDS indicates that the pipeline appears to pass no closer than 1-2 nmi south of the preferred (4.5-mile) site.

3.18 Candidate Site Surveys

3.18.1 1986 Video, Still Camera, and Sidescan Sonar Survey, Port Everglades Harbor

A video, still-camera, and sidescan sonar survey was conducted in March 1986 CSA for the Port Everglades Harbor 4-mile site. Sidescan sonar (with total coverage of 200 m [984 ft] for each transect) and bathymetry data were collected along five north-south transects and five east-west transects spaced at 0.25 nmi (0.463 km) intervals. Video and still-camera data were collected along the initial survey transect, the nearshore north-south transect near the northern limit of the site.

CSA also conducted a video, still-camera, and sidescan sonar survey in September-October 1986 for the Port Everglades Harbor 4-mile site. Data were collected along two north-south survey transects along the eastern and western sides of the site and extending to the north. Underwater video and still camera coverage was obtained for 7.5 nmi (13.9 km) along the eastern survey transect and 7.3 nmi (13.5 km) along the western survey transect. Still photographs were taken at intervals of less than 164 ft (50 m) along each survey transect. Sidescan sonar transects roughly paralleled the video and still-camera transects and extended for 10.7 nmi (19.8 km) and 10.5 nmi (19.4 km) on the east and west transects, respectively. Sidescan sonar lateral coverage was approximately 492 ft (150 m) on each side, giving a total coverage of 984 ft (300 m) for each transect. Bathymetric data were collected along all transects.

Depths within the March 1986 survey area ranged from 577 ft (176 m) on the western edge of the survey area to 699 ft (213 m) on the eastern edge; no high-relief ledges, rock outcrops, or steep slopes were detected within the survey area. Depths within the September-October survey area ranged from 625 ft to 640 ft (190.5 m to 195 m) along the western transect and from 681 ft to 712 ft (207.5 m to 217 m) along the eastern transect. No high-relief ledges or steep slopes were detected within the survey area.

The tapes from these surveys show that the bottom consisted of fine- to coarse-grained sediment with large rocks or small boulders. The rocks appeared to be isolated boulders rather than outcrops of an underlying structure. There was no evidence of extensive rock outcropping. Evidence of biological activity (i.e., small holes, burrows, depressions, and mounds) and low numbers of epifauna associated with the rocks (i.e., anemones, portunid crabs, scorpionfish, hydrozoans, occasional octocoral fans, and hake) were observed. All other epifauna observed were typical soft-bottom species.

3.18.2 1989 Video Survey, Palm Beach Harbor

A field survey and sampling expedition was conducted in 1988-1989 by CSA for the Palm Beach Harbor 3-mile site, which encompasses the 4.5-mile site. The collected data included bathymetry, underwater video of benthic habitat, water column profiles, water quality samples, bottom sediment chemistry samples, and benthic biotal samples. Ten sampling stations were designated in the vicinity of the project area, four within the 3-mile site and six outside the site. Three of these sites were designated as water quality sampling sites (one within the 3-mile site, three outside), and seven sites were designated as benthos/sediment sampling sites (three within the 3-mile site, four outside). Biomass determinations and tissue analysis was conducted on the benthic biota retrieved from the sampling stations. Video and bathymetry surveys were conducted along eight north-south transects at intervals of approximately 0.5 nmi (0.93 km).

Depths at the survey site ranged from 354 ft (108 m) northwest of the proposed ODMDS to 607 ft (185 m) in the southeast corner of the proposed site. Water depths increased in an east-southeast direction.

The tapes from this survey show that the bottom substrate consisted of fine-grained sediment with no visible exposed rock or outcrops. The near-bottom water was turbid and visibility was generally less than 3 ft (1 m). There was a significant amount of evidence of biological disturbance (i.e., small holes, burrows, depressions, and mounds) and low numbers of epifauna (i.e., sea pens, anemones, sand dollars, crabs, and unidentified fish).

3.18.3 1998 Sediment/Water Quality Survey, Palm Beach and Port Everglades Harbors

A sediment and water quality survey was by EPA in 1998 for both interim sites and all candidate sites except the Palm Beach Harbor 3-mile site as coverage of this site in previous surveys was deemed adequate. Nine sampling stations were designated for Palm Beach Harbor sites, and 11 sampling stations were designated for Port Everglades Harbor Sites. The data from this survey, in conjunction with that of previous surveys, provided two benthic stations (physical and biotal) within each candidate site and two stations upcurrent and downcurrent of each site. Hydrography, water chemistry, benthos characteristics, granulometry, sediment chemistry, and biotal characteristics were all analyzed at each site using data obtained from the samples retrieved on this survey.

The results of this survey indicated that salinity, dissolved oxygen, and transmissivity data in the water masses over the sampled sites were similar to open ocean waters and deviated little among the various sites. Water quality analyses for trace metals, PCBs, and pesticides yielded very low levels for all parameters, although total petroleum hydrocarbons were higher than expected, particularly in the deepwater sites. The sites contained similar grain size distributions, with the Port Everglades sites exhibiting a slightly coarser distribution. Oil and grease, total petroleum hydrocarbons, pesticides, and PCBs were generally below detection limits in the sediment samples. Copper and lead were the only metals detected in significant amounts in the sediments. Annelids and arthropods were numerically dominant in macroinfaunal samples. All sampled sites exhibited a smilar number of taxa dominated by the same major taxonomic groups.

3.18.4 1998 Sidescan Sonar Survey, Palm Beach and Port Everglades Harbors

EPA conducted a sidescan sonar survey in August 1998 of all five candidate sites and the interim candidate sites. Survey data was collected along north-south transects utilizing a Klein™ 595 system at a speed of three knotts and range setting of 250 m. Only 100 kHz data was collected as cable length prohibited the collection of the 500 kHz frequency. Transect spacing was set at 250-300 m for the candidate sites and at greater down and up current of the sites. A minimum coverage of 100% was achieved in all surveyed areas with 100% overlap within the preferred alternatives. The 250-m transect spacing provided a transverse resolution of 1 m. Transverse resolution is the ability to discern two separate objects that lay near one another in a line parallel to the tow path. It is a function of vessel speed, range, and beam spread (Fish and Carr, 1990). A minimum of 0.5 nmi was surveyed to the eat and west of each alternative site and 1 nmi north and south. Benthic photography for ground-truthing was unsuccessful due to high currents. Grab sampling from a previous survey was also analyzed for ground-truthing.

Survey Results-Palm Beach Harbor 4.5-Mile Site

The sidescan sonar data indicated a relatively uniform fine sandy bottom throughout the site and areas 2 miles to the north and 2 miles south of the site (see Figure 7 in Appendix E). Grab samples taken earlier in the year showed sediments in the 4.5-mile site to consist of a grey silty fine sand with shell fragments. The mean grain sizes for the area ranged from 0.14 to 0.17 mm with 25-35% silts and clays (EPA, 1999). No areas of hard bottom or potential wrecks were identified through the sidescan record within the site or north or south of the site.

Survey Results-Palm Beach Harbor 9-Mile Site

The sidescan sonar data indicated a relatively uniform fine sandy bottom throughout the site. Grab samples taken from this area showed a grey-green silty fine sand with some shell fragments. The mean grain size was approximately 0.21 mm with 18-23% silts and clays (EPA, 1999). Only a few scattered targets were detected throughout the survey area, none suggesting any significant resources.

Survey Results-Port Everglades Harbor 4-Mile Site

Results show a relatively uniform sandy bottom of medium reflectance with an east/west running low relief ridge through the middle of the candidate site and an east/west running low relief ridge to the northwest of the candidate site. Grab samples taken earlier from the survey area showed a grey, slightly to very silty fine sand with shell fragments. The mean grain size was approximately 0.18 mm with 16% silts and clays (EPA, 1999). The low relief areas are identified by a generally darker acoustic signal with little to no shadows. The bottom appeared consistent with the descriptions provided by the CSA video surveys discussed above. Numerous scattered acoustic targets of varying size were detected throughout the survey area. These were identified by dark acoustical signals with shadows. Most of these were located outside of the candidate site boundaries. Five of the acoustical targets were identified as possible wrecks based on the shape of their reflective return and shadow. All of these targets are outside of the candidate site boundaries and three are within the Navy South Florida Testing Facility Testing Range.

Survey Results-Port Everglades Harbor 7-Mile Site

The southern portion of the survey area (south of 26^{o} 8" latitude) consisted of a relatively uniform low relief hard bottom. Attempts at benthic sampling of the area earlier in the survey resulted encountered hard bottom. Some rocks were retrieved that consisted of fossiliferous limestone, slightly dolomitic with magnesite dendrites. They were identified as being from the Floridian Aquifer of the Suwanee Formation (EPA, 1999). The northern portion of the survey area showed a relatively uniform sandy bottom. Grab samples taken from this area showed a grey, slightly silty, fine sand with shell fragments. The mean grain size was approximately 0.22 mm with 10-18% silts and clays (EPA, 1999). Only a few scattered targets were detected throughout the survey area. These were identified by dark acoustical signals with shadows.