APPENDIX D

Essential Fish Habitat Assessment for the Phipps Ocean Park Beach Restoration Project Palm Beach County, Florida

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1.0 INTRODUCTION

The Town of Palm Beach (Town), Palm Beach County proposes to dredge approximately 1.5 million cubic yards of compatible sediment on approximately 1.9 miles of critically eroded beach between Sloan's Curve and the Ambassador South II Condominium, including Phipps Ocean Park and the Palm Beach Par 3 Golf Club in Palm Beach County, Florida (DEP reference monument R-116 to R-126). The recommended borrow source includes two sites located approximately 3,500 feet offshore and between 1.5 and 2.6 miles south of the fill area mid-point. Both borrow sites contain sand with a composite grain size approximately 0.22 millimeters and 0.32 millimeters, compared to the native beach which is historically composed of sand with a 0.34 millimeters grain size. A minimum of 3.1 acres of artificial reef is proposed for natural nearshore hardbottom mitigation. This beach nourishment Project has been determined to be sufficient in maintaining a beach along most of the Project shoreline until the projected renourishment in eight years.

In March 1997, the Town of Palm Beach updated its Comprehensive Coastal Management Plan (CCMP) which was originally prepared in 1986. The purpose behind the update was to consider the changes which have occurred to the Palm Beach Island shoreline over the prior decade and to update shoreline management goals and objectives. Although many of the original shoreline management initiatives have been implemented during this time, the beach shoreline is still eroding at a significant rate. Between 1994 and 2000, the mean erosion rate was a loss of approximately 202,000 cubic yards for Palm Beach Island annually (See SEIS Section 3.1-3.2). The Phipps Ocean Park Beach Restoration Project is necessary because the current and projected condition of the shoreline in the Project area is subject to chronic erosion and, if left unabated, will result in damage and loss of the beach, public recreational areas, and important shoreline habitat. The Project will fulfill four fundamental and legitimate purposes:

1. The Project is required to mitigate for the long-term erosion impacts of Lake Worth Inlet and the armored coastline north of the Project area.

2. The Project is required to provide and maintain storm protection to upland improvements, structures, and infrastructure.

3. The Project is required to restore and maintain the beach for public recreational use, thus benefiting the local economy and creating a public asset.

4. The Project is required to restore and maintain the beach for marine turtle nesting habitat.

2.0 ESSENTIAL FISH HABITAT DESIGNATION

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act of 1976 and the 1996 Sustainable Fisheries Act, an Essential Fish Habitat (EFH) assessment is necessary for this Project. An EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." *Waters* include aquatic areas and their associated physical, chemical, and biological properties that are use by fishes and may include areas historically used by fishes. *Substrate* includes sediment, hardbottom, structures underlying the waters, and any associated biological communities. *Necessary* means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. *Spawning, breeding, feeding, or growth to maturity* covers all habitat types used by a species throughout its life cycle. Only species managed under a federal fishery management plan (FMP) are covered (50 C.F.R. 600). The act requires federal agencies to consult on activities that may adversely influence EFH designated in the FMPs. The activities may have direct (e.g., physical disruption) or indirect (e.g., loss of prey species) effects on EFH and may be site-specific or habitat-wide. The adverse result(s) must be evaluated individually and cumulatively.

2.1 Assessment

Surveys conducted by Continental Shelf Associates, Inc. (CSA) during January and February 2000, determined that the predominant bottom type within the Project area is sand followed by areas of exposed hardbottom and sand-veneered hardbottom (CSA, 2000). In addition, the surveys located a small artificial reef constructed of concrete, a small section of PEP reef, in approximately 2.2 meters of water. The aquatic communities associated with these different bottom types and the water column have been identified as EFH in accordance with the amendment to the Fishery Management Plans of the South Atlantic Region (SAFMC, 1998). The toe of the fill will extend approximately 143.3 to 190 meters offshore and is expected to impact approximately 3.1 acres of nearshore hardbottom, and also impact sand bottom areas and the water column adjacent to the Project area. Impacts associated with placement of beach fill are unavoidable. However, the temporary disruption of the water column, sand bottom, and hardbottom areas that may provide habitat or contribute to aquatic food chains will be minimized by implementing strict management practices to reduce turbidity. These practices along with the construction of a 3.1 acre artificial reef will serve as mitigation for nearby hardbottom direct impacts.

2.2 Managed Species

Phipps Ocean Park is located along the Atlantic coastline south of Lake Worth (Palm Beach) Inlet and north of South Lake Worth (Boynton) Inlet. A total of 192 fish species representing 62 families, has been recorded from natural nearshore hardbottom habitats in this area of southeast Florida (Gilmore, 1977; Vare, 1991; Lindeman and Snyder, 1999). Thirty-seven of these fish species are listed under the Affected Fishery Management Plans and Fish Stocks of the Comprehensive EFH Amendment (SAFMC, 1998). Consequently, the Project area has been designated as EFH for these fishes, brown shrimp, white shrimp, pink shrimp, and spiny lobster (Table 1). Six coastal migratory pelagic fish species have been included owing to their distribution patterns along the Florida coast. In addition, the nearshore bottom and offshore reef habitats of South Florida have also been designated as Essential Fish Habitat-Habitat Areas of Particular Concern (EFH-HAPC) (SAFMC, 1998). Over 60 species of coral can occur off the coast of Florida all of which fall under the protection of the management plan (SAFMC, 1998). Fourteen of these coral species are listed as endangered by the Florida Committee on Rare and Endangered Plants and Animals (SAFMC, 1998).

Table 1 Managed Species Identified by the South Atlantic Fishery Management Council That Are Known to Occur in Palm Beach County, Florida

Common Name	Taxa
Balistidae	
Gray Triggerfish	*Balistes capriscus*
Queen Triggerfish	*Balistes vetula*
Ocean Triggerfish	*Canthidermis sufflamen*
Carangidae	
Yellow Jack	*Caranx bartholomaei*
Blue Runner	*Caranx crysos*
Crevalle Jack	*Caranx hippos*
Bar Jack	*Caranx rubber*
Greater Amberjack	*Seriola dumerili*
Coryphaenidae	
Dolphin [1]	*Coryphaena hippurus*
Ephippidae	
Spadefish	*Chaetodipterus faber*
Haemulidae	
Black Margate	*Anisotremus surinamensis*
Porkfish	*Anisotremus virginicus*
Margate	*Haemulon album*
Tomtate	*Haemulon aurolineatum*
Smallmouth Grunt	*Haemulon chrysargyreum*
French Grunt	*Haemulon flavolineatum*
Spanish Grunt	*Haemulon macrostomum*
Cottonwick	*Haemulon melanurum*
Sailors Choice	*Haemulon parra*
White Grunt	*Haemulon plumieri*
Blue Stripe Grunt	*Haemulon sciurus*

Common Name	Taxa
Labridae	
Puddingwife	*Halichoeres radiatus*
Hogfish	*Lachnolaimus maximus*
Lutjanidae	
Mutton Snapper	*Lutjanus analis*
Schoolmaster	*Lutjanus apodus*
Gray Snapper	*Lutjanus griseus*
Dog Snapper	*Lutjanus jocu*
Mahogany Snapper	*Lutjanus mahogoni*
Lane Snapper	*Lutjanus synagris*
Yellowtail Snapper	*Ocyurus chrysurus*
Rachycentridae	
Cobia [1]	*Rachycentron canadum*
Scombridae	
Little Tunny [1]	*Euthynnus alletteratus*
King Mackerel [1]	*Scomberomorus cavalla*
Spanish Mackerel [1]	*Scomberomorus maculates*
Cero [1]	*Scomberomorus regalis*
Serranidae	
Black Sea Bass	*Centropristis striata*
Rock Hind	*Epinephelus adscensionis*
Goliath Grouper	*Epinephelus itajara*
Red Grouper	*Epinephelus morio*
Black Grouper	*Mycteroperca bonaci*
Gag	*Mycteroperca microlepis*
Sparidae	
Sheepshead	*Archosargus probatocephalus*
Jolthead Porgy	*Calamus arctifrons*
Invertebrates	
Brown Shrimp	*Farfantepenaeus aztecus*
Pink Shrimp	*Farfantepenaeus duorarum*
White Shrimp	*Litopenaeus setiferus*
Spiny Lobster	*Panulirus argus*

[1] Coastal Migratory Pelagic Fish Species

The species addressed in this section consist of fishes and invertebrates of both recreational and commercial importance that are managed under the Magnuson-Stevens Fishery Conservation and Management Act (PL94-265).

2.2.1 Crustacea

2.2.1.1 Life Histories

2.2.1.1.1 Brown Shrimp

Brown shrimp larvae occur offshore and migrate from offshore as post-larvae from January through November with peak migration from February through April. Post-larvae move into the estuaries primarily at night on incoming tides. Once in the estuaries, post-larvae seek out the soft silty/muddy substrate common to both vegetated and non-vegetated, shallow estuarine environments. This environment yields an abundance of detritus, algae, and microorganisms that comprise their diet at this developmental stage. Post-larvae have been collected in salinities ranging from zero to 69 ppt with maximum growth reported between 18° and 25°C, peaking at 32°C (Lassuy, 1983). Maximum growth, survival, and efficiency of food utilization has been reported at 26°C (Lassuy, 1983). The density of post-larvae and juveniles is highest among emergent marsh and submerged aquatic vegetation (Howe et al., 1999; Howe and Wallace, 2000), followed by tidal creeks, inner marsh, shallow non-vegetated water, and oyster reefs. The diet of juveniles consists primarily of detritus, algae, polychaetes, amphipods, nematodes, ostracods, chironomid larvae, and mysids (Lassuy, 1983). Although some of their potential prey will initially be lost during dredging activities, recovery will be rapid (Culter and Mahadevan, 1982; Saloman et al., 1982) and they can forage in adjacent areas that have not been impacted as they emigrate offshore. Emigration of sub-adults from the shallow estuarine areas to deeper, open water takes place between May through August, with June and July reported as peak months. The stimulus behind emigration appears to be a combination of increased tidal height and water velocities associated with new and full moons. After exiting the estuaries, adults seek out deeper (18 m), offshore waters in search of silt, muddy sand, and sandy substrates. Adults reach maturity in offshore waters within the first year of life.

2.2.1.1.2 Pink Shrimp

Of the three penaeid shrimp species, pink shrimp is the most prevalent in Florida waters. Consequently, the pink shrimp fishery is the most economically important of all fisheries in Florida. Spawning of pink shrimp occurs in oceanic waters at depths of 4 to 48 meters and possibly deeper (Bielsa et al., 1983) where adult females lay demersal eggs. Spawning takes place year round in some areas (e.g., Tortugas Shelf), but peak spawning activity appears to coincide with maximum bottom water temperatures (Bielsa et al., 1983). Recruitment of planktonic post-larvae into estuarine and coastal bay nursery areas occurs in the spring and late fall during flood tides. Post-larvae become benthic at approximately 10 millimeters TL and prefer areas with a soft sand or mud substrate mixture containing sea grasses (Bielsa et al., 1983; Howe et al., 1999; Howe and Wallace, 2000). Pink shrimp spend from 2 to 6 months in the nursery ground prior to emigration. During this time there is a dietary shift from nauplii and microplankton to polychaetes, ostracods, caridean shrimps, nematodes, algae, diatoms, amphipods, mollusks, and mysids, regarding post-larvae and juveniles, respectively (Bielsa et al., 1983). Although some of their potential prey will initially be lost during dredging activities, recovery will be rapid (Culter and Mahadevan, 1982; Saloman et al., 1982) and they can forage in adjacent areas that have not been impacted as they emigrate offshore. Emigration from the nursery grounds to offshore occur year round with a peak during the fall and a smaller peak during the spring. The greatest concentrations of adults have been reported between 9 and 44 meters, although some have been found as deep as 110 meters in Florida waters. Although detailed dietary studies concerning adults are non-existent, Williams (1955) reported foraminiferans, gastropod shells, squid, annelids, crustaceans, small fishes, plant material, and debris in the stomachs of adults collected in North Carolina estuaries.

2.2.1.1.3 White Shrimp

White shrimp spawn along the South Atlantic coast from March to November, with May and June reported as peak months along the offshore waters of northeast Florida. Spawning takes place in water ≥ 9 meters deep and within 9 kilometers from the shore where they prefer salinities of ≥ 27 ppt (Muncy, 1984). The increase in bottom water temperature in the spring is thought to trigger spawning. After the demersal eggs hatch, the planktonic post-larvae live offshore for approximately 15-20 days. During the second post-larval stage, they enter Florida estuaries in April through early May by way of tidal currents and flood tides and become benthic. During this larval stage, the diet consists of zooplankton and phytoplankton. It has been documented that juvenile white shrimp tend to migrate further upstream than do juvenile pink or brown shrimp; as far as 210 kilometers in northeast Florida (Pérez-Fartante, 1969). Juveniles prefer to inhabit shallow estuarine areas with a muddy substrate with loose peat and sandy mud and moderate salinity. Juvenile white shrimp are benthic omnivores (e.g., fecal pellets, detritus, chitin, bryozoans, sponges, corals, algae, annelids) and feed primarily at night. White shrimp usually become sexually mature at age one during the calendar year after they hatched. The emigration of sexually mature adults to offshore waters is influenced primarily by body size, age, and environmental conditions. Studies have shown that a decrease in water temperature in estuaries triggers emigration in the south Atlantic (Muncy, 1984). The life span of white shrimp usually does not extend beyond one-year.

2.2.1.1.4 Spiny Lobster

The spiny lobster inhabits the coastal waters from North Carolina to Rio de Janeiro, Brazil, including Bermuda and the Gulf of Mexico. The Florida spiny lobster is a valuable species both commercially and recreationally, and supports Florida's second most valuable shellfishery. During its life cycle, the spiny lobster occupies three different habitats (Marx and Herrnkind, 1986). The phyllosoma larvae are planktonic and inhabit the epipelagic zone of the Caribbean, Gulf of Mexico, and the Straits of Florida. The duration of the phyllosome stage is approximately 6 to 12 months. A brief (several weeks) non-feeding, oceanic phase follows, where the larva metamorphoses into a puerulus offshore. The pueruli migrate to shore by night using specialized abdominal pleopods. Large concentrations of pueruli have been recorded along the southeast Florida coast and the southern shores of the Florida Keys year round, with a peak in the spring and a lesser peak in the fall. In addition, these large concentrations are usually associated with the new and first quarter lunar phases. When suitable inshore substrate is encountered by pueruli, they rapidly settle out of the water column and within days molt into the first juvenile stage. The specific factors that stimulate post-larval settlement are not well understood. Known nursery areas of young benthic larvae and juveniles consist of macroalgae beds along rocky shorelines interspersed with seagrasses where they live a solitary existence (Marx and Herrnkind, 1986). Juveniles larger than 20 millimeters CL tend to aggregate in biotic (e.g., sponges, small coral heads, sea urchins) and abiotic (ledges) structures in protected bays, including estuaries with high salinity. As adults, spiny lobsters inhabit coral reef crevices, rocky outcroppings, and ledges. Refuge availability plays an important role regarding population distribution because spiny lobsters do not have the ability to construct dens. However, in a study where additional artificial structures were placed in Biscayne Bay, FL, the population was re-distributed, but the number of spiny lobsters in the Bay did not increase (Marx and Herrnkind, 1986). Consequently, the south Florida population may be limited by recruitment, emigration, food, and other factors.

2.2.1.2 Summary of Impacts to Shrimps and Spiny Lobsters

As outlined by SAFMC (1998), EFH-HAPCs for penaeid shrimps include coastal inlets and both State identified overwintering areas and nursery habitats. Seagrass beds common to the bays of Florida are particularly important areas. Essential fish habitats for spiny lobster are varied including nearshore shelf/oceanic waters, shallow, benthic subtidal areas, seagrass beds, soft sediment, coral and both live and hardbottom, sponges, algal communities, mangroves, and the Gulf Stream which it uses for dispersion (SAFMC, 1998).

The Project area includes sand bottom, sand-veneered hardbottom, hardbottom, and water column that may be used by all three penaeid species and spiny lobster as post-larvae, juvenile, and adults. The Project would impact a relatively small area of the sand and hardbottoms, and the impacts would be minor. Some possible refuge may be lost in regards to the impact to the hardbottom areas; however, additional refuge would be created by the construction of a 3.1 acre artificial reef to serve as replacement habitat. Penaeid shrimp and spiny lobster would be temporarily displaced, but would quickly return to the Project area.

2.2.2 Habitat Areas of Particular Concern

2.2.2.1 Coral and Live Hardbottom Habitat

The South Atlantic Fisheries Management Council has designated nearshore hardbottom, and offshore reef areas within the study site as EFH. The nearshore bottom and offshore reef habitats of South Florida have also been designated as Essential Fish Habitat-Habitat Areas of Particular Concern (EFH-HAPC) (SAFMC, 1998). Over 60 species of coral can occur off the coast of Florida all of which fall under the protection of the management plan (SAFMC, 1998). Fourteen of these coral species are listed as endangered by the Florida Committee on Rare and Endangered Plants and Animals (SAFMC, 1998).

The warm waters of the Florida current are the most dominant hydrographic feature beginning at Palm Beach, Florida and continuing south. Consequently, the Carolinian corals in this area (> 4 km offshore) are replaced by a highly diverse hardbottom community which is dominated by gorgonian corals (SAFMC, 1998). The dominant species of hermatypic corals in this area include the large star coral, *Montastraea cavernosa*, the small star coral, *M. annularis*, lettuce coral, *Agaricia lamarcki*, and brain coral, *Diploria clivosa* (SAFMC, 1998). On the other hand, the inshore (< 4 km offshore) habitat in this area consists primarily of sandy plains which are interspersed with hardbottom reefs composed of exposed *Anastasia* limestone, sabellariid worm reefs, and small corals (SAFMC, 1998). A total of 325 species of invertebrates and plants were reported in similar nearshore hardbottom habitats at Sebastian Inlet located approximately 150 kilometers north of Palm Beach (SAFMC, 1998).

CSA conducted a series of surveys using video and still photography in January - February 2000, to characterize and map hardbottom features within the Project site (CSA, 2000). In addition, photoquadrats were collected along the nearshore survey area at three different stations to estimate the percent biota cover. Results of the post-survey analyses of video and still photography data as well as that observed *in situ* by divers follows.

A total of 28 benthic organisms were identified from the 31 transects (Table 2). The rock substrates along the northern-most transects were colonized with sponges (*Dysidea* sp., *Monanchora* sp., and *Ircinia* sp.), sabellariid worm rock, and soft corals (sea plumes, sea whips, and sea fans). In relatively shallow water, the nearshore rock substrates located parallel to shore were colonized with algae (*Caulerpa* sp., *Dictyota* sp., and *Padina* sp.), yellow boring sponges, sabellariid worm rock, and lesser starlet coral. Colonies of lesser starlet coral were primarily isolated in an area between DNR monuments R-120 to R-122 and frequently near the eastern portions of exposed rock outcrops. Sabellariid worm rock usually occurred in areas of shallow low relief rock substrate near the shorebreak. In some instances, the worm rock was eroded and did not appear to be growing. The biota cover at station 1 (DNR monument R-118.5) which is the northern-most station was dominated by algae (≥ 50%) and a boring sponge (≤ 25%). Station 2 (DNR monument R-120.5) consisted primarily of hard coral (< 5%), boring sponge (≤ 20%), and algae (≤ 15%). Station 3 (DNR monument R-124) had the least amount of coverage overall which was dominated by algae (≤ 10%). As the above data reflects this nearshore hardbottom habitat lacks the complexity and diversity found on hardbottom resources located in deeper water offshore.

Table 2 Benthic Taxa Identified from Video and Still Photography Surveys Performed in the Project Area (CSA, 2000)

Common Name	Taxa
Algae	
Red Algae	*Botryocladia occidentalis*
Oval Blade Algae	*Caulerpa prolifera*
Green Grape Algae	*Caulerpa racemosa*
Branched Algae	*Dictyota* sp.
Red Algae	*Hypnea* sp. (?)
Leaf Algae	*Padina* sp.
Annelida	
Sabellariid Worm	*Phragmatopoma lapidosa*
Arthropoda	
Barnacle	unidentified *Cirripedia*
Tidal Spray Crab	*Plagusia depressa*
Ascidacea	
Tunicate	Didemnidae
Cnidaria	
Burrowing Anemone	Ceriantharia (unidentified)
Eliptical Star Coral	*Dichocoenia stokesii*
Brain Coral	*Diploria* sp.
Hydroid	Hydrozoa (unidentified)
Fire Coral	*Millepora* sp.
Sea Fan	*Muricea* sp.
Sea Plume	*Pseudopterogorgia* sp.
Sea Whip	*Pterogorgia* sp.
Lesser Starlet Coral	*Siderastrea radians*
Echinodermata	
Arrowhead Sand Dollar	*Encope michelini*
Sea Cucumber	Holothuroidea (unidentified)
Mollusca	
Fuzzy Chiton	*Acanthopleura granulata*
Florida Fighting Conch	*Strombus alatus*
Porifera	
Yellowing Boring Sponge	*Cliona* spp.
Sponge	*Dysidea* sp.
Sponge	*Holopsamma* sp. (?)
Sponge	*Ircinia* sp.
Sponge	*Monanchora* sp.

2.2.2.2 Summary of Impacts to Coral and Hardbottom Habitat

The beach nourishment project at Phipps Ocean Park was designed by Coastal Technology using a series of numerical model simulations (GENESIS), historical data, and engineering judgements. These models were used to evaluate the impact to the nearshore hardbottom and sand-veneered hardbottom present in the Project area. This hardbottom is composed in part of sessile organisms including macro algae, sponges, sabellariid worm rock, and to a lesser extent soft and hard corals. The Beach Fill with Nourishment Alternative was selected as the Preferred Project Alternative because it fulfilled the project's goals and objectives between DEP reference monuments R-116 to R-126, while minimizing the environmental impacts. The toe of the fill will extend approximately 430 to 570 feet offshore and is expected to directly impact approximately 3.1 acres of nearshore hardbottom. Because this hardbottom is immediately adjacent to the shoreline, dredging-associated impacts to this habitat are unavoidable. Primary impacts to this hardbottom community will include excessive sediment deposition, resulting in the burial of the algal, sponge, and coral community. The GENESIS model indicated a secondary impact involving material spreading to the north of the Project site eight years after the fill. It is estimated that this material will impact 0.13 acres within the northern region of the 3.1 acres of nearshore hardbottom in the Project site. Any spreading from the fill section will be minor in volume, confined to the nearshore zone, be essentially complete after the first year of adjustment, and will not result in long-term burial or damage to nearshore hardbottom north of the Project area. Additional secondary impacts include excessive suspended solids, which will reduce algal production (due to reduced light levels) and also interfere with the ability of corals to feed heterotrophically, and may diminish biological integrity and diversity.

Guidelines for physical and biological monitoring during construction are set forth in the FDEP permit and are summarized in Appendix F of the SEIS. To meet State of Florida turbidity standards and the associated State permit, a temporary mixing zone of 300 meters offshore and 1,000 meters down current from the point of sand discharge onto the beach fill area will be monitored and maintained. In addition, shore parallel sand dikes shall be constructed and maintained at the beach disposal area at all times during discharge onto the beach. These activities are consistent as outlined in the FDEP permit.

Measures taken to avoid, minimize, and compensate for adverse impacts include reducing the fill placement area to avoid nearshore hardbottom resources, use of buffer zones and strict construction vessel control requirements to avoid and minimize impact to hardbottom resources in the vicinity of the borrow areas, and construction of a 3.1 acre mitigation reef in water depths ranging from 5 to 13 feet north of the Project area. The Florida DEP considers the proposed mitigation plan adequate to offset the anticipated impacts to the hardbottom habitat based on several factors. One, construction of the proposed mitigation reef will provide structural habitat for motile organisms. Second, the mitigation reef is expected to provide similar structural habitat for these motile organisms. Third, installation of the mitigation reef six months prior to impact, and the close proximity of this reef to the impact site will allow these motile organisms to relocate immediately to the mitigation reef.

Although the sessile, hardbottom organisms located within the impact site will be lost due to sediment deposition, colonization of the mitigation reef by epi-benthic species similar to those inhabiting the natural hardbottom is expected to occur within the first year. Other nearshore artificial reef mitigation projects have been successful in offsetting such impacts.

Due to the lack of research and long-term monitoring on nearshore hardbottom communities, determining what amount of cumulative impact is significant is difficult. Past impacts within the region do not appear to have had any adverse or significant cumulative impact on the resource, even when combined with present actions proposed to occur within two years. Proposed future actions within the Study Area do add cumulatively to the impact and are adverse. Due to the significant amount of adjacent habitat remaining, it is unlikely that the amount of hardbottom habitat will become a limiting resource. Consequently, the impacts are most likely adverse, but not significant, since the adjacent habitat is clearly not limited. Monitoring of present and future projects could provide substantial information on the actual extent of spatial and temporal indirect affects. The response of the hardbottom community to these disturbances could be highly beneficial in determining whether additional projects implemented in the Study Area or region would have a significant cumulative affect. Reassessment of cumulative affects should be performed based on scientific monitoring prior to implementation of future projects.

2.2.2.3 Beach and Sand Bottom Habitat

The beaches of Palm Beach County are exposed and receive the full impact of wind and wave action. Species richness is usually low in these habitats, but localized species can be abundant. Typical beach fauna in the proposed Project area includes the mole crab (*Emerita talpoida*), surf clam (*Donax variabilis*) and ghost crab (*Ocypode quadrata*). These and other beach infauna provide food for a wide variety of shorebirds such as plovers (*Charadrius spp.)*, willets *(Catoptrophorous semipalmatus*), and ruddy turnstones (*Arenaria interpres*). Drift algae and *Sargassum* stranded on the beach may support large numbers of insects and other invertebrate life. Beyond the beach, polychaetes, gastropods, portunid crabs, and burrowing shrimp are the most abundant fauna in shallow, soft bottom habitats. As depth increases, these habitats are dominated by amphipods, polychaetes, and bivalves (*Donax* sp., *Tellina* sp.). This nearshore habitat is managed under the Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265).

2.2.2.4 Summary of Impacts to Beach and Sand Bottom Habitat

Several studies have examined the effects of beach nourishment on benthic fauna and sediments. Nelson (1989) reviewed literature regarding the effects of beach nourishment on beach sand fauna and concluded that minimal biological effects occurred. Mortality of some organisms may occur where grain size is a poor match to existing sediments; however, recovery was rapid. Common beach invertebrates of the southeastern U.S. including the mole crab, *Emerita talpoida*, the surf clam *Donax* sp., and the ghost crab *Ocypode quadrata* did not exhibit any significant impacts resulting from beach nourishment (Nelson, 1989). In a review of beach nourishment effects on beach fauna, Hackney et al. (1996) came to the same conclusions as Nelson (1989), with the suggestion that beach nourishment should take place during the winter months to minimize the impacts, and that the sand should match as closely as possible.

In a beach renourishment project in Panama City Beach, Florida, Culter and Mahadevan (1982) concluded that the initial destruction of the benthic community at the borrow sites was followed by a rapid recovery which was virtually complete after one-year. There were minor differences in sediment parameters, but no differences in fauna in or out of the borrow sites were observed. The benthic community at this site consisted primarily of polychaetes, bivalves, gastropods, amphipods, brachyuruns, and amphipods. No species that required a permanent attachment site and only a few tube dwelling organisms were present at the site. The overall findings were that no long-term adverse environmental effects as a result of beach renourishment existed within the nearshore area and that no adverse conditions were present at the borrow sites.

In another study conducted along Panama City Beach, Saloman et al. (1982) observed an immediate decline in the benthic community followed by a rapid recovery within 8 - 12 months as indicated by species richness, abundance, and diversity. The benthic community was composed of primarily annelids, arthropods, mollusks, and to a much lesser extent platyhelminths, nematodes, echinoderms, and hemichordates. After one-year post-dredging, some short-term ecological changes including minor alterations in sediment, and a small decline in the diversity and abundance of benthic invertebrates were reported. However, no long-term effects were observed regarding the benthic community, sediments, and water quality along the shore and in and around the borrow sites.

The removal of sediment from the proposed borrow area will directly impact the benthic habitat including both the infaunal and epifaunal community. Initially this will result in a significant, but localized reduction in the abundance, diversity, and biomass of the immediate fauna. Species affected most are those that have limited capabilities or are incapable in avoiding the dredging activities. The fauna most affected will include predominantly invertebrates such as crustaceans, echinoderms, mollusks, and annelids, as well as finfish larvae. However, due to the relatively small area that will be impacted as viewed on a spatial scale, impacts to the benthic community will be minimal due to the relatively short period of recovery regarding infaunal communities following dredging activities (Culter and Mahadevan, 1982; Saloman et al., 1982). Adjacent areas not impacted will most likely be the primary source of recruitment to the impacted area. To minimize any adverse effects to beach fauna, the proposed Project will be conducted during the winter months, outside the recruitment window for many impacted species, and a high quality source of sand containing a small percentage of fine material will be used. The proposed Project will not have any significant, long lasting impacts on the beach sand infaunal communities.

2.2.3 South Atlantic Snapper-Grouper Complex

Palm Beach County, Florida is designated as EFH for 37 species of reef fishes (Table 1) that are listed under the Affected Fishery Management Plans and Fish Stocks of the Comprehensive EFH Amendment (SAFMC, 1998). Collectively, these 37 species, representing eight different families, are all members of the 73 species Snapper-Grouper Complex as outlined by SAFMC (1998). The association of these fishes with coral or hardbottom structure, vegetated and unvegetated inshore areas during some period of their life cycle, and their contribution to a reef fishery ecosystem is why they are included in the snapper-grouper plan. A discussion of how these fishes utilize the different inshore habitats and the hardbottom and reef communities follows.

2.2.3.1 Life History

<u>2.2.3.1.1</u> <u>Balistidae</u>

Palm Beach County is designated as EFH for three species of triggerfishes (Table 1). Collectively, these triggerfishes inhabit shallow inshore areas (e.g., bays, harbors, lagoons, sandy areas, grassy areas, rubble rock, coral reefs, artificial reefs, or dropoffs adjacent to offshore reefs) to offshore waters as deep as 275 meters. These triggerfishes, especially the gray and queen triggerfish are an important component of the reef assemblage of both natural and artificial reefs (Vose and Nelson, 1994). Information regarding balistid reproduction is limited and varied (Thresher, 1984). The basic balistid (e.g., gray triggerfish) spawning behavior involves the production of dermersal, adhesive eggs that are thought to stick to corals and algae near or on the bottom. On the other hand, spawning of both the ocean and queen triggerfish takes place well off the bottom over relatively deep water where pelagic eggs are released. Unfortunately, egg and larval development is poorly understood regarding most species; however, a long (≥ 1 yr) planktonic stage appears common for many species. As juveniles, it has been suggested that they are planktonic, taking refuge among floating masses of *Sargassum* (Johnson and Saloman, 1984). During this stage of development, the diet consists of primarily zooplankton associated with the *Sargassum* or drifting in the water column. The exact timing or the environmental cues that trigger settlement is not well understood. However, juvenile gray triggerfish as small as 16 - 17 centimeters SL have been reported to colonize hardbottom habitats (Thresher, 1984). After juveniles take on a benthic existence, their diet shifts to benthic fauna including algae, hydroids, barnacles, and polychaetes. All triggerfish feed diurnally and are well adapted to prey upon hard-shell invertebrates, especially adults. The diet of adult ocean triggerfish includes large zooplankton and possibly drifting seagrasses, algae, mollusks, and echinoderms. Adult gray and queen triggerfish feed primarily on sea urchins, but in their absence, will shift to other benthic invertebrates such as crabs, chiton, and sand dollars (Frazer et al., 1991; Vose and Nelson, 1994). All three triggerfishes are commercially important (especially the queen triggerfish) in the aquarium trade and to some extent as a gamefish.

2.2.3.1.2 Carangidae

Palm Beach County is designated as EFH for five carangids (Table 1) because they utilize the offshore and possibly inshore areas adjacent to the study area. Spawning of the bar jack, yellow jack, blue runner, and the crevalle jack takes place in offshore waters associated with a major current system such as the Gulf Stream from February through September (Berry, 1959). Consequently, these four species have an offshore larval existence. Data indicates that peak spawning months for blue runners is May through July (Shaw and Drullinger, 1990). Although spawning data regarding the greater amberjack doesn't exist, it is assumed that it is similar to the other four species. As young juveniles, crevalle jacks migrate into inshore waters at about 20 millimeters SL whereas blue runners don't migrate into inshore areas until their late juvenile stage (Berry, 1959). Young bar jacks have a tendency to remain offshore and yellow jacks occur inshore only occasionally as juveniles (Berry, 1959). Based on collections of juveniles regarding these four species, there is some indication that there is a mobile, northward population of developing young in the Gulf Stream that developed from spawning that occurred in more southern waters (Berry, 1959). As juveniles and sub-adults, blue runners occur singly or in schools while juveniles have a high affinity for *Sargassum* and other floating objects in the Gulf Stream off southeast Florida (Goodwin and Finucane, 1985). Blue runners are a fast growing, long-lived species which attains 75% of its maximum size in its first three to four years of life (Goodwin and Johnson, 1986). The greater amberjack is a far ranging species that inhabits inlets, shallow reefs, rock outcrops, and wrecks with reef fishes such as snappers, sea bass, grunts, and porgies (Manooch and Potts, 1997a). They are generally restricted to the continental shelf to depths as great as 350 meters (Manooch and Haimovici, 1983). Small individuals (< 1 m SL) are usually found in water < 10 meters deep while larger individuals frequent waters 18 to 72 meters deep (Manooch and Potts, 1997b). Greater amberjack are a fast growing species and are recruited to the headboat fishery in the Gulf by age four and fully recruited to the fishery by age eight (Manooch and Potts, 1997a; Manooch and Potts, 1997b).

All five carangids are popular sport fishes among recreational fishers, but not as popular commercially where they are harvested using handlines, bottom longlines, and in some cases traps and trawls. Some Florida fishers feel that amberjack are being exposed to too much fishing pressure, especially owing to their attraction to reefs which make them an easy target for overfishing (Manooch and Potts, 1997a). However, as of 1997 there is no evidence of overfishing in both the Gulf of Mexico and southeast Florida (Manooch and Potts, 1997b).

2.2.3.1.3 Ephippidae

Palm Beach County is designated as EFH for the spadefish because as juveniles it inhabits shallow sandy beaches, estuaries, jetties, wharves, and other inshore areas, as well as deeper offshore habitats as adults. Spawning which takes place from May to September involves an offshore migration as far as 64.4 kilometers (Chapman, 1978; Thresher, 1984). Although no data exists regarding egg and larvae development in nature, small individuals (~ 1-2 cm TL) appear inshore in early summer (Walker, 1991). These small juveniles are commonly observed drifting motionless along side vegetation (e.g., *Sargassum*). It has been suggested that they mimic floating debris and vegetation to escape predation. As spadefish mature they move further offshore where large schools will take residence around wrecks, oil and gas platforms, reefs, and occasionally open water. Spadefish are opportunistic feeders, preying upon a variety of items including small crustaceans, worms, hydroids, sponges, sea cucumbers, salps, anemones, and jellyfish. In certain areas, the spadefish is an important game fish.

2.2.3.1.4 Haemulidae

Palm Beach County is designated as EFH for eleven species of grunts (Table 1). Collectively, these grunts inhabit shallow inshore areas (e.g., estuaries, mangroves, jetties, piers, seagrass beds), coral reefs, rock outcrops, and offshore waters as deep as 110 meters. Although most of the life history data concerning grunts (Cummings et al., 1966; Manooch and Barans, 1982; Darcy, 1983; McFarland et al., 1985; Sedberry, 1985) are from studies of tomtate, white grunt, French grunt, blue stripe grunt, and the margate, the general information can probably be applied to the other species as well. As a reef-dwelling species, grunts are probably similar to other roving benthic predators such as snappers and groupers that migrate to select spawning sites along the outer reef and participate in group spawning at dusk. Some data suggests that spawning takes place over much of the year, while other suggests spawning peaks in later winter and spring (Manooch and Barans, 1982; Darcy, 1983). The eggs are pelagic as well as the planktonic larvae. After this pelagic larval stage that may last several weeks, they settle to the bottom as benthic predators (Darcy, 1983). The juveniles are commonly found in seagrass beds, near mangroves, and other inshore, shallow areas. Studies in the Caribbean regarding French grunt, suggested that fertilization and settlement was associated with the lunar cycle (quarter moon, rather than the full or new moon) and daily tidal cycles (rising and falling tides), respectively (McFarland et al., 1985). Juveniles are diurnal planktivores that tend to feed higher in the water column than adults on amphipods, copepods, decapods, and small fishes (Darcy, 1983; Sedberry, 1985). The transformation to adult involves a change in feeding strategy from diurnal planktivore to nocturnal benthic foraging. Most grunts take refuge near the reef in schools, but at dusk they disperse and forage over the reef, along sandy flats, and grass beds for crustaceans, fishes, mollusks, polychaetes, and ophiuroids. Because of these nocturnal foraging migrations, grunts are a major source of food for higher tropic level, piscivorous fishes. In addition, they are very important to hardbottom reef-related fisheries regarding the energy transfer from sandy expanses to these reefs (Darcy, 1983). Several species of grunt such as the tomtate and white grunt have some commercial and recreational importance. Tomtate are commonly caught by sport fishers from shore, bridges, jetties, and inshore waters by boat. In the southeastern United States, the hook and line fishery is the most important method of commercial harvest regarding tomtate (Darcy, 1983). In addition, tomtate are collected using traps, trawls, and seines off southeast Florida. Commercially, tomtate are usually discarded or cut up and used as bait for the grouper or snapper fishery. Similarly, white grunt are commercially harvested by hook and line along the southeast United States and is also a common sport species.

2.2.3.1.5 Labridae

Palm Beach County is designated as EFH for two species of wrasse (Table 1). The EFH for both species ranges from shallow reef and patch reefs, areas of hard sand and rock, and/or along areas inshore or offshore of the main reef. The puddingwife appears to be depth restricted as it is rare to find this species in waters deeper than 13.3 meters, while the hogfish inhabits areas as shallow as 3.3 meters deep (Thresher, 1980). Reproduction in wrasses involves a complex reproductive system based on protogynous hermaphroditism which features a complex socio-sexual system involving sex reversal, alternate spawning systems and variable color patterns (Thresher, 1980). Both species participate in group (the dominant or terminal male with a harem of females) broadcast spawning that occurs along the outer edge of a patch reef or on an extensive reef complex along the outer shelf during the summer months (Thresher, 1984). Hogfish spawn during the late afternoon or early evening hours, while puddingwife spawning is synchronized with strong tidal or shoreline currents. Although the exact duration of both the planktonic egg and larval stage is unknown, some records suggest that the latter may be as short as one month before the larvae settle out. Newly settled hogfish and puddingwifes use common areas around grass flats and the shallow reef, respectively. The smallest juveniles on record collected on reefs are approximately 10 millimeters SL. Other data suggests that puddingwife as small as 30 millimeters SL may be sexually active. As a benthic predator, the diet of adult hogfish consists of mollusks, echinoderms, and small crustaceans (primarily crabs). Owing to their large size, hogfish are popular with sport fishers.

2.2.3.1.6 Lutjanidae

Palm Beach County is designated as EFH for seven species of snapper (Table 1). Collectively, the EFH of these snappers ranges from shallow estuarine areas (e.g., vegetated sand bottom, mangroves, jetties, pilings, bays, channels, mud bottom) to offshore areas (e.g., hard and live bottom, coral reefs, rocky bottom) as deep as 400 meters (Allen, 1985; Bortone and Williams, 1986). Like most snappers, these seven species participate in group spawning, which indicates either an offshore migration or a tendency for larger, mature individuals to take residency in deeper, offshore waters. Data suggests that adults tend to remain in one area. Both the eggs and larvae of these snappers are pelagic (Richards et al., 1994). After an unspecified period of time in the water column, the planktivorous larvae move inshore and become demersal juveniles. The diet of these newly settled juveniles consists of benthic crustaceans and fishes. Juveniles inhabit a variety of shallow, estuarine areas including vegetated sand bottom, bays, mangroves, finger coral, and seagrass beds. As adults, most are common to deeper offshore areas such as live and hardbottoms, coral reefs, and rock rubble.

However, adult mutton, gray, and lane snapper also inhabit vegetated sand bottoms with gray snapper less frequently occurring in estuaries and mangroves (Bortone and Williams, 1986). The diet of adult snappers includes a variety fishes, shrimps, crabs, gastropods, cephalopods, worms, and plankton. All seven species are of commercial and/or recreational importance In particular, the mutton, gray, lane, and yellowtail snapper comprise the major portion of Florida's snapper fishery (Bortone and Williams, 1986).

2.2.3.1.7 Serranidae

Palm Beach County is designated as EFH for six species of sea bass (Table 1). Collectively, the EFH of these sea bass ranges from shallow estuarine areas (e.g., seagrass beds, jetties, mangrove swamps) to offshore waters as deep as 300 meters (Heemstra and Randall, 1993; Jory and Iverson, 1989; Mercer, 1989). Like all other serranids, these six species are protogynous hermaphrodites; functioning initially as females only to undergo a sexual transformation at a later time to become functional males. In addition, like all other serrranids, these six species produce offshore planktonic eggs, moving into shallow, inshore water during their post-larval benthic stage. Juveniles inhabit estuarine, shallow areas such as seagrass beds, bays, harbors, jetties, piers, shell bottom, mangrove swamps, and inshore reefs. Juveniles feed on estuarine dependent prey such as invertebrates, primarily crustaceans, which comprise the majority of their diet at this developmental stage. As sub-adults and adults, they migrate further offshore taking refuge along rocky, hard, or live bottom, on artificial or coral reefs, in crevices, ledges, or caverns associated with rocky reefs. During this stage in their lives, the bulk of their diet consists of fishes, supplemented with crustaceans, crabs, shrimps, and cephalopods. Except for the Goliath grouper, the other species discussed in this section have some importance to commercial and/or recreational fisheries.

2.2.3.1.8 Sparidae

Palm Beach County is designated as EFH for two species of porgy (Table 1). The EFH regarding both species ranges from shallow inshore waters (e.g., vegetated areas, jetties, piers, hard and rock bottoms), to deeper offshore waters with natural or artificial reefs, offshore gas and oil platforms, or live bottom habitat (Darcy, 1986). Although nothing is known regarding the sexuality of the jolthead porgy, it is most likely a hermaphroditic species which is widely documented in sparids (Thresher, 1984). On the other hand, the sheepshead has been determined to be a protogynous hermaphrodite through histological investigations (Render and Wilson, 1992). Information regarding tropical sparids is limited, but in general, it suggests long spawning seasons. Little is known about spawning behavior, but it is presumed that both the sheepshead and the jolthead porgy produce pelagic eggs some distance off the bottom. Whether or not spawning takes place in pairs or in spawning aggregations has not been documented. Settlement of sheepshead larvae to the bottom occurs at about 25 millimeters TL (Thresher, 1984). Based on their dentition, both species are well suited for benthic feeding of sessile and motile invertebrates (e.g., copepods, amphipods, mysids, shrimp, bivalves, gastropds) which are bitten off from hard substrates and vegetation. Neither sparid is considered a schooling species, although they will form small groups composed of several individuals occasionally. There is no direct commercial or sport fishery associated with either sparid; however, both are fished in coastal waters. Both species are an important constituent of grassbed communities in shallow water and live bottom communities in deeper water (Darcy, 1986).

2.2.3.2 Summary of the Impacts to the Snapper-Grouper Complex Fishes

The Project area includes sand bottom, sand-veneered hardbottom, hardbottom, and water column that may be used by these managed fishes and their prey. The Project would impact a relatively small area of the sand and hardbottoms, and the impacts would be minor and short-term. Some possible refuge and related prey may be lost in regards to the impact to the hardbottom and sand areas; however, additional refuge would be created by the construction of a 3.1 acre artificial reef to serve as replacement habitat. The Project will cause localized turbidity during construction; however, turbidity would be minimized using the management practices outlined in Appendix F, so that any impacts would be minor and temporary. These fishes and possible prey would be temporarily displaced, but should quickly return to the Project area.

2.2.4 Coastal Migratory Pelagics Complex

Palm Beach County, Florida is designated as EFH for six species of coastal migratory pelagic fishes that are listed under the Affected Fishery Management Plans and Fish Stocks of the Comprehensive EFH Amendment (SAFMC, 1998). Collectively, these six species, representing three different families, are all members of the Coastal Migratory Pelagics Fish Species as outlined by SAFMC (1998). The association of these fishes or their prey with coral or hardbottom structure, or inshore waters during some period of their life cycle and their contribution to a reef fishery ecosystem is why they are included in this complex. A discussion of how these fishes utilize the different inshore habitats and the hardbottom and reef communities follows.

2.2.4.1 Life History

<u>2.2.4.1.1 Coryphaenidae</u>

The dolphin is oceanic and distributed worldwide in both tropical and subtropical waters. Data suggest that this species may be involved in northward migrations during the spring and summer with some occasional movements and migrations being controlled by drifting objects in open waters. Spawning which is poorly documented, it thought to take place in oceanic waters where pairing of the sexes occurs (Ditty et al., 1994). Based on the occurrence of young dolphin in the Florida Current, spawning may be almost year round (November - July) with peak activity in January through March (Palko et al., 1982). Owing to the oceanic distribution of this species, it's not surprising that both the egg and larval stages are pelagic. Upon hatching, this species experiences rapid growth throughout its life with both sexes reaching sexually maturity within the first year (Palko et al., 1982). In the Straits of Florida, female dolphins begin to mature at 350 millimeters FL and become fully mature at 550 millimeters FL. On the other hand, the smallest, mature male on record is 427 millimeters FL. The maximum life span of dolphin is estimated at four years. The diet of dolphin alters throughout its life cycle (Palko et al, 1982). As larvae, they feed primarily on crustaceans, with copepods as the primary prey item. Adult dolphin are opportunistic, top-level predators. They feed upon a variety of fishes (e.g., flyingfish) and crustaceans, especially those species commonly associated with drifting flotsam and *Sargassum* in the Florida Current. As a prized food, dolphin are sought by both commercial and sport fishers. They are most commonly taken using hook and line around the edges of the continental shelf. In southern Florida, based on recreational catches, they appear most frequently March through August and then again September through February (Palko et al., 1982).

2.2.4.1.2 Rachycentridae

Cobia are distributed worldwide in tropical, subtropical, and warm temperate waters where they inhabit estuarine and shelf waters depending of their life stage. They appear to associate with structures such as pilings, wrecks and other forms of vertical relief (e.g. oil and gas platforms) and favor the shade from these structures (Mills, 2000). Cobia spawn offshore where external fertilization takes place in large spawning aggregations; however, the pelagic eggs have been collected at both inshore and offshore stations. Based on past collections of gravid females, spawning takes place from mid May, extending through the end of August off South Carolina (Shaffer and Nakamura, 1989). Consequently, spawning may start slightly early off the southeast coast of Florida. Eggs have been collected in the lower Chesapeake Bay inlets, North Carolina estuaries, in coastal waters 20 - 49 meters deep, and near the edge of the Florida Current and the Gulf Stream (Ditty and Shaw, 1992). Ditty and Shaw (1992) suggested that cobia spawn during the day since all the embryos they examined were at similar stages of development. Cobia exhibit rapid growth and may attain a length of 2 meters FL and are known to live 10 years (Shaffer and Nakamura, 1989). Although females grow faster than males, they attain sexual maturity later in life. Sexual maturity is attained by males at approximately 52 centimeters FL during the second year and at approximately 70 centimeters FL for females during their third year (Shaffer and Nakamura, 1989). They are adaptable to their environment and can utilize a variety of habitats and prey. Cobia are voracious predators that forage primarily near the bottom, but on occasion do take some prey near the surface. Their favorite benthic prey are crabs, and to a much less extent other benthic invertebrates and fishes. No predator studies have been conducted, but dolphin fish have been known to feed on small cobia. Adults may be found solitary or in small groups and are known to associate with rays, sharks, and other larger fishes. Cobia is fished both commercially and recreationally; however, the commercial harvest is mostly incidental in both the hook and line and net fisheries. The recreational harvest is primarily through charter boats, party boats and fishers fishing from piers and jetties. Tagging studies have documented a north-south, spring-fall migration along the southeast United States and an inshore-offshore, spring-fall migration off South Carolina (Ditty and Shaw, 1992).

2.2.4.1.3 Scombridae

Palm Beach County is designated as EFH for six scombrid species (Table 1). Collectively, the EFH of these epipelagic scombrids ranges from clear waters around coral reefs, and inshore and continental shelf waters (Collette and Nauen, 1983). Spawning of king and Spanish mackerel takes place May through September with peaks in July and August. The cero is thought to spawn year round with peaks in April through October, whereas little tunny spawn from April to November. Batch spawning takes place in tropical and subtropical waters, frequently inshore. The eggs are pelagic and hatch into planktonic larvae. Both king and Spanish mackerel are involved in migrations along the western Atlantic coast. With increasing water temperatures, Spanish mackerel move northward from Florida to Rhode Island between late February and July, and back in the fall (Collette and Nauen, 1983). King mackerel have been reported to migrate along the western Atlantic coast in large schools; however, there appears to be a resident population in south Florida as this species is available to sport fishers year round (Collette and Nauen, 1983). Although the little tunny is epipelagic, it typically inhabits inshore waters in schools of similar size fish and/or with other scombrids (Collette and Nauen, 1983). The diet of these scombrids consists of primarily fishes and to a lesser extent penaeid shrimp and cephalopods. The fishes that make up the bulk of their diet are small schooling clupeids (e.g., menhaden, alewives, thread herring, anchovies), atherinids, and to a lesser extent jack mackerels, snappers, grunts, and half beaks (Collette and Nauen, 1983). The king and Spanish mackerel are important both commercially and recreationally. The king mackerel is a valued sport fish year round in Florida while the sport fisheries for Spanish mackerel in southern Florida are concentrated in the winter months. The cero is a valued sport fish that is taken primarily by trolling. The little tunny is not of commercial or recreational interest.

2.2.5 Summary of Impacts to the Coastal Migratory Pelagics Complex Fishes

The Project area includes sand bottom, sand-veneered hardbottom, hardbottom, and water column that may be used by these managed fishes and their prey. The Project would impact a relatively small area of the sand and hardbottoms, and the impacts would be minor and short-term. Some possible refuge and related prey may be lost in regards to the impact to the hardbottom and sand areas; however, additional refuge would be created by the construction of a 3.1 acre artificial reef to serve as replacement habitat. These fishes and possible prey would be temporarily displaced, but should quickly return to the Project area.

2.3 Associated Species

Associated species consist of living resources that occur in conjunction with the managed species discussed earlier. These living resources would include the primary prey species and other fauna that occupy similar habitats.

2.3.1 Invertebrates

The removal of sediment from an inshore borrow site will directly impact the benthic habitat including both the infaunal and epifaunal community. Initially this will result in a significant, but localized reduction in the abundance, diversity, and biomass of the immediate fauna. Species affected most are those that have limited capabilities or are incapable in avoiding the dredging activities. The fauna most affected would include predominantly invertebrates such as crustaceans, echinoderms, mollusks, and annelids. However, due to the relatively small area that will be impacted as viewed on a spatial scale, impacts to the benthic community will be minimal due to the relatively short period of recovery regarding infaunal communities following dredging activities (Culter and Mahadevan, 1982; Saloman et al., 1982). Adjacent areas not impacted would most likely be the primary source of recruitment to the impacted area.

Zooplankton are primarily filter feeders and suspended inorganic particles can foul the fine structures associated with the feeding appendages. Zooplankton that feed by ciliary action (e.g., echinoderm larvae) would also be susceptible to mechanical affects of suspended particles (Sullivan and Hancock, 1977). Zooplankton mortality is assumed from the physical trauma associated with dredging activities (Reine and Clark, 1998). The overall impact on the zooplankton community should be minimal due to the limited extent and transient nature of the sediment plume.

2.3.2 Fishes

The larvae of the managed fish species discussed in this document are hatched from planktonic eggs (excluding the gray triggerfish) and the larvae are also planktonic. The primary source of larval food is microzooplankton with a dietary overlap in many species and specialization (Sale, 1991). Algae is most likely food for only the youngest larval stages of certain species or for those larvae that are very small after hatching, and then only for a short time. The algae-eating larvae eventually switch to animal food while they are still small. At this time, varying life history stages of copepods become the dominant food and to a lesser extent cladocerans, tunicate and gastropod larvae, isopods, amphipods, and other crustacea.

Larval feeding efficiency depends on many factors such as light intensity, temperature, prey evasiveness, food density, larva experience, and olfaction to mention a few (Gerking, 1994). Larval fishes are visual feeders that depend on adequate light levels in the water column which reduces the reaction distance between larval fish and prey. Suspended sediment and dispersion due to dredging activities will increase turbidity levels in the Project area temporarily. This will reduce light levels within the water column which may have a short term negative effect regarding feeding efficiency. In addition, turbidity can affect light scattering which will impede fish predation (Benfield and Minello, 1996). However, because the sediment plumes are transient and temporary, and the area to be impacted is relatively small when examined on a spatial scale, the overall impact to the larval fish population and consequently, the adult population should be minimal (Sale, 1991). The majority of larval fish mortality will be attributed to the physical trauma associated with the dredging activities.

Similar to larval fishes, both juvenile and adult fishes are primarily visual feeders. Consequently, the visual effects of turbidity as outlined above will apply. Also, suspended sediment can impair feeding ability by clogging the interraker space of the gill raker or the mucous layer of filter feeding species (Gerking, 1994). However, because these fishes have the ability to migrate away from the dredging activities, the impact of the sediment plumes which are transient and temporary should be minimal. Although few adult fishes have been entrained by dredging operations (McGraw and Armstrong, 1988; Reine and Clark, 1998), most juvenile and adult fishes again have the ability to migrate away from the dredging activities. Consequently, dredging operations would have minimal effects on juvenile and adult fishes in the area. In addition, the reduction of benthic epifaunal and infaunal prey, and pelagic prey in the immediate area would have little affect on juvenile and adult fishes because they can migrate to adjacent areas that have not been impacted to feed.

In addition to the managed fish species discussed in this document, many other inshore and pelagic fishes in various stages of life occur in the Project area (Gilmore, 1977; Vare, 1991; Lindeman and Snyder, 1999). A total of 192 species have been recorded in association with nearshore hardbottom habitats in southeast Florida (Lindeman and Snyder, 1999). In the study conducted by Lindeman and Snyder (1999), 80% of the fishes collected at all sites were early life stages. In addition, eight of the top ten fish species were consistently represented by early life stages, and the use of hardbottom habitats was recorded for newly settled stages of more than 20 species of fishes. This provided evidence that suggested that these nearshore hardbottom habitats along the mainland coast of east Florida may serve as nursery grounds for a wide diversity of juvenile reef fishes. Lindeman and Snyder (1999) estimated that 34 species of fishes used nearshore hardbottom habitats as a nursery. These nearshore hardbottom habitats may actually serve several nursery-related roles such as, 1) a centrally located refuge for incoming early life stages that would exhibit considerably greater mortality if shelter were not available, 2) habitat for juvenile fishes (e.g., gray snapper, blue stripe grunt) that emigrate out of inlets to offshore waters, and 3) an area to promote growth because of the greater availability of prey at these hardbottom habitats.

Lindeman and Snyder (1999) observed a significant decrease in fish diversity and abundance upon burial of the nearshore hardbottom habitat at Carlin Park. Displacement of most fishes from Carlin Park was permanent because most of their habitat was eliminated (the closest substantial habitat structure was 0.8 km away), and due to the loss of reef-associated food. These affects may have been reduced if the mitigation reefs had been constructed immediately after dredging activities were completed rather than three years after the hardbottom habitat was buried.

2.3.3 Summary of Impacts to Associated Species

Many of the fishes associated with nearshore hardbottom habitats as observed in past studies (Gilmore, 1977; Vare, 1991; Lindeman and Snyder, 1999), would be common along Phipps Ocean Park, Palm Beach County. It is assumed that the impacts to this Project area regarding these fishes would be less than observed at Carlin Park because nearby hardbottom habitat is available for refuge and potential prey, and construction of the mitigation reef is to be completed 6 months prior to the commencement of the beach nourishment Project. The majority of juvenile and adult fishes would be displaced to adjacent habitat during dredging operations, consequently, mortality of these fishes should be minimal. Only those species that produce demersal eggs and that comprise the demersal ichthyofauna could potentially be impacted more heavily than their pelagic counterparts. Mortality of demersal eggs and larvae would be expected from the physical trauma associated with dredging operations. Suspended sediments produced by these operations can affect the feeding activity of pelagics as outlined earlier; however, the impact to these fishes should be minimal due to the limited extent and transient nature of the sediment plume.

3.0 CONCLUSIONS

The proposed Project will adversely impact unvegetated, sand bottom, hardbottom, sand-veneered hardbottom, and water column. The use of the management practices outlined in Appendix F will help to lessen impacts associated with water quality and turbidity in the Project area. Overall, the hardbottom resources affected are ephemeral and low quality when compared to the hardbottom resources found throughout the remainder of Palm Beach County. Construction of a mitigation reef in a more stable offshore environment will create higher quality nearshore hardbottom habitat than is currently available within the study area. Construction of the mitigation reef should occur either before or concurrently with the construction of the beach nourishment to counteract the loss of fish diversity found in similar beach protection projects (Lindeman and Snyder, 1999). Significant adverse impacts to those species associated with EFH within the Project area are not expected.

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