FISH AND WILDLIFE COORDINATION ACT REPORT
FOR
BREVARD COUNTY (MID-REACH) SHORE PROTECTION PROJECT
GENERAL RE-EVALUATION REPORT
BREVARD COUNTY, FLORIDA

FINAL

Submitted to:
Department of the Army
Jacksonville District U.S. Army Corps of Engineers
Planning Division, Environmental Branch
Jacksonville, Florida

Prepared by:
U.S. Fish and Wildlife Service
North Florida Ecological Services Office
Jacksonville, Florida
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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (Corps) requested a Fish and Wildlife Coordination Act Report (FWCAR) from the U.S. Fish and Wildlife Service (Service) on the environmental effects of a proposed beach nourishment project along the Mid-Reach in Brevard County, Florida. The project includes a fill area 7.78 linear miles adjacent to a significant nearshore hard bottom area that is designated as Essential Fish Habitat (EFH). The Corps has estimated that up to 3.0 acres of this hard bottom will be buried by the fill. The borrow area for this project is under separate review and not evaluated in this FWCAR.

The Corps proposes standard beach nourishment protocols in terms of timing and actions to reduce impacts on nesting sea turtles and shorebirds. The Corps also proposes the deployment of a limestone mitigation reef (acreage to be determined), several hundred meters seaward in 15 feet of water in an effort to provide compensation for the loss of the natural nearshore hard bottom.

The currently proposed project may affect the threatened loggerhead (*Caretta caretta*), the endangered green (*Chelonia mydas*), the endangered leatherback (*Dermochelys coriacea*), the endangered hawksbill (*Eretmochelys imbricata*) and the endangered Kemp's ridley (*Lepidochelys kempii*) sea turtles. It may also interrupt the wintering piping plover (*Charadrius melodus*) and nesting shorebirds including the Wilson's plover (*Charadrius wilsonia*). The sand overburdens will bury numerous species of burrowing invertebrates that support the beach structure and ecological function.

The project will cause the mortality, through burial, of many nearshore sessile and some motile aquatic species. The habitat and function provided by the buried nearshore hard bottom will be lost. The total direct impacts which include vertical relief, underside of ledges and interstitial spaces is not known. The future maintenance of this beach will require routine sand nourishment and repeated burials of this area preclude long term recovery.

The extent of the indirect effects of the project such as turbidity and sedimentation is not completely known at this point. The ephemeral nature of the nearshore hard bottom in areas not directly impacted makes the level of functionality that may remain as a result of additional turbidity difficult to determine. Extensive post-monitoring of the nearshore hard bottom is necessary.

The mitigation proposed for the nearshore hard bottom losses is not yet a proven form of appropriate mitigation. The offshore deployment of a limestone artificial reef of equivalent volume, surface area, and complexity may provide partial compensation for a sector of the community lost from the nearshore (e.g. *Phragmatapoma*, algae and some invertebrate species). However, based on literature reviews and discussions with the National Oceanic Atmospheric Administration's Marine Fisheries Service (NOAA Fisheries), it remains to be proven that the assemblage of juvenile and larval fish species, and certain invertebrates currently relying on the nearshore hard bottom will recruit to the mitigation reef placed in deeper waters. Ecological function there may not mitigate for the loss of the nearshore hard bottom.

Service Recommendations:

The nearshore hard bottom proposed to be buried should be evaluated prior to the nourishment. The habitat and function of the nearshore hard bottom communities should be assessed with routine surveys designed to assess populations and life cycles of the various macroalgae, invertebrates and fish. A long-term monitoring strategy should be created prior to the first nourishment event. This long-term monitoring strategy should focus on the direct, indirect and cumulative impacts of the nourishment on the nearshore hard bottom ecosystem. A study of the turbidity before, during, and after the proposed project should be conducted.

Since the Mid-Reach is a Resource Category 1, the Service recommends no loss of habitat value/ecological function through avoidance, minimization and mitigation. Prior to the project, the resource agencies have discussed avoidance and minimization to the maximum extent practicable. Mitigation has been analysis through the Uniform Mitigation Assessment Method (UMAM) process.

The proposed mitigation reef concept should be further evaluated in advance of the burial of the nearshore hard bottom. It is important to demonstrate through a comparative analysis that the proposed mitigation reefs placed in deeper water actually replace the ecological functions/refugee that nearshore habitats provide for early life stages of species. An alternative mitigation plan should be in place if the proposed mitigation reef does not in fact mitigate for the near shore hard bottom functional loss or the impacts are more than expected. Consideration should be made for those functions that remain unknown. Since the mitigation plan is experimental, continual monitoring is necessary to ensure that the habitat corridor, water quality, substrate (attachment site), shelter, nesting area, feeding area and nursery area assessed through the UMAM process are mitigated.

The resource agencies should conduct a meeting with the information received after the first nourishment event and prior to the subsequent nourishment event to discuss the actual impacts and decide if these losses were mitigated.

The resource agencies should discuss the long-term impacts and the initial proposed mitigation ratios after the post-monitoring reports of the nearshore hard bottom and the mitigation reef are available. If the monitoring demonstrated that the mitigation ratios are no longer valid with the new information received, an alternative plan should be discussed that would replace the ecological functions/refugee that nearshore habitats impacted.

Threatened and endangered species impacts will be discussed in detail in a forthcoming Biological Opinion (BO).

INTRODUCTION

This FWCAR comprises the recommendations of the Service based on surveys and investigations, as provided for in Section 2(b) of the Fish and Wildlife Coordination Act (FWCA) (48 stat. 401, as amended) for the Brevard County Mid-Reach Shore Protection Project General Re-evaluation Report. This FWCAR was prepared in accordance with guidance issued by Region 4, Service (*Policy and Guidance on Fulfillment of Fish and Wildlife Coordination Act Responsibilities in the Corps of Engineers Water Resources Development Program,* March 1987). The Corps is the lead Federal agency for implementation of this project, heretofore referred to as the Mid-Reach project.

The report reviews the tentatively selected plan and the locally preferred plan (LPP), and summarizes potential beneficial and adverse effects on nearshore marine resources with special attention to hard bottom habitat, fish and wildlife resources, water quality and fisheries. Recommendations are provided to help maximize project benefits, and avoid, minimize, and compensate for incidental adverse effects in accordance with the Service's *Mitigation Policy (Federal Register 46(15):7644-7663).*

Although effects on recreation and economics are not addressed in this report, the Service supports the Project's Purpose and Need, which includes minimizing loss of dune habitats within the project area. Careful selection and implementation of an alternative, mitigation of adverse effects, and enhancement of other affected habitat in the Project area, would help ensure that the Project meets its purpose, and provides the greatest possible ecosystem benefits. Evaluations and recommendations were based on resource descriptions and project information available at the time of report preparation, including the biological assessments, draft descriptions of project alternatives (USACE, Revised Scope C.A.R., May 2007); field surveys, reports; draft engineering designs, the Mid-Reach Draft Supplemental Environmental Impact Statement and interviews with non-governmental organizations (NGO).

In accordance with the FWCA, copies of this draft report have been provided to *National Oceanic and Atmospheric Administration (NOAA) Fisheries and Florida Fish and Wildlife Conservation Commission (FWC)* for their review and input. The draft report also will appear as an appendix to the Project's SEIS. As a draft document, the contents of the report are provisional and therefore subject to revision. The Service invites comments regarding the data, assessments, views, and recommendations provided in the report. Consultation pursuant to the FWCA will continue throughout project planning, and a final FWCA report will be submitted to Corps for their consideration prior to completing the Project's Record of Decision (ROD).

The purpose of this report is to assess and minimize the impacts of existing fish and wildlife resources in and adjacent to the Corps shore projection project in the Mid-Reach section of Brevard County, Florida. Nourishment of the Atlantic shoreline of Brevard County was authorized by the River and Harbor Act of 1968 (N.A. 1992). The focus of this FWCAR is on the tentatively selected plan, the LPP, and how they may impact the nearshore marine resources with special attention to hard bottom habitat, areas of importance to fish and wildlife, occurrence of threatened or endangered species, water quality, and fisheries.

The FWCAR will:
a. Discuss significant fish and wildlife and other known resources within the area and the diversity and density of species and habitat present,
b. Identify potential impacts, management opportunities and mitigation during project design, construction and operation,
c. Determine and evaluate the effects of potential increases in siltation and sedimentation as a result of the proposed project on nearby natural habitats;
d. Discuss alternatives to minimize or avoid significant impacts to natural resources and provide recommendations to mitigate possible impacts; and
e. Include copies of correspondence pertaining to the FWCA studies and the report in the appendices.

Background:

The Final Environmental Impact Statement (EIS) Brevard County Shore Protection Study was completed in 1996 and included plans for several alternatives to provide beach nourishment and shoreline protection in Brevard County (Corps, 1996). That document included the Service's Coordination Act Report (Service, 1995) in the appendices. The 1996 EIS evaluated several options, however, the limited information on the nearshore hard bottom did not allow for planners to adequately address the potential impacts to the 7.78 mile portion of the hard bottom referred to as the "Mid-Reach". Figure 1 shows the vicinity map and the general area of concern including the central portion that represents the Mid-Reach. The Service and NOAA Fisheries coordinated with Brevard County and the Corps and found data deficiencies for the Mid-Reach which resulted in the agencies concurring on shore protection measures that were limited to the areas north and south of the Mid-Reach. The agencies determined that a more intensive investigation of the environment and potential impacts to the nearshore hard bottom and associated flora and fauna along the Mid-Reach would be required before proposed options would be further considered.

The Brevard County shore protection project was authorized under a resolution adopted September 23, 1982, by the Committee on Public Works and Transportation and the U.S. House of Representatives. Since that time, correspondence between Brevard County and the Corps reflects the county's continued interest in nourishing problem areas. The Corps posted the Public Notice in January 1992, and the Service responded with a Planning Aid Report in March 1992. Additional public scoping meetings took place on November 29, 2005, in Satellite Beach, Florida to encourage public comment on the project. Field reconnaissance related to the FWCAR preparation was performed in 2005 and early 2006.

From 2003 to 2006, additional studies provided baseline information for the SEIS (SEIS in progress, Continental Shelf Associates (2005), Dynamac Corporation (2005), Olsen Associates, (2003)) to augment the Final EIS Brevard County Shore Protection Study (Corps, 1996).

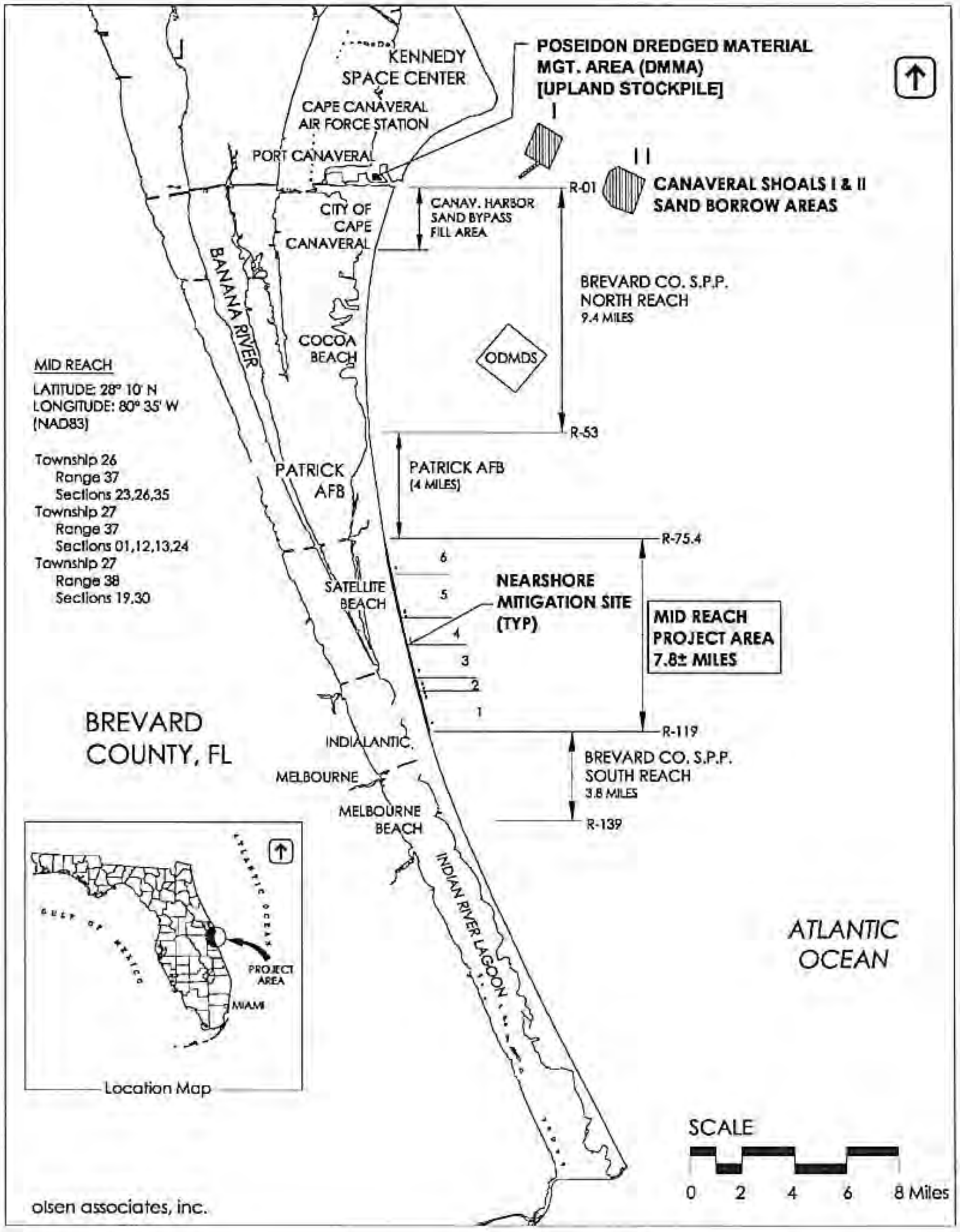

Figure 1. Brevard County, Florida and shore protection areas with recent details of rock distribution within the Mid-Reach project area.

A meeting was convened on December 6, 2005, including representatives of the Corps, NOAA Fisheries, Florida Department of Environmental Protection (FDEP), FWC, Olsen Associates, Dynamac Corporation, and the Service.

On June 13, 2007, an additional interagency meeting was held by the Corps and included the NOAA Fisheries, FDEP, FWCC, Olsen Associates, Inc., Brevard County, East Coast Biologists, and the Service. The meeting included discussions on the selected plan, on-going mitigation tests and general ideas for monitoring plan development.

PROJECT DESCRIPTION

The Mid-Reach Study was authorized by Section 418 of the Water Resources and Development Act of 2000 (Public Law 106-541). The entire 7.78-mile length of the Mid-Reach shoreline has been critically eroded with 62% of its oceanfront development anticipated to be lost to storm damage during the next 50 years. In cooperation with Brevard County, the Corps evaluated over 90 alternative solutions that could maximize shore protection benefits while minimizing environmental impacts. For planning purposes, the Corps divided the Mid-Reach into six segments or "reaches" with the southern most reach being labeled "1" and the northern most being "6". Shore protection alternatives evaluated by the Corps included multiple combinations of those listed in Table 1 along the six reaches of this beach area.

Detailed engineering and economic analyses were performed by the Corps to identify beach nourishment as the tentatively selected plan (TSP, chosen in June 2007). Beach nourishment is generally regarded as the shore protection alternative that would provide the most benefits for the Mid-Reach. Under this scenario, dredged material would be pumped from Canaveral Shoals and into an upland placement area at Cape Canaveral Air Force Station. The material would then be trucked to the Mid-Reach. Bulldozers would be employed to grade the material and complete the fill template. This solution is highly desirable to the Corps as it imparts protection for shoreline infrastructure while at the same time provides a recreational beach. As for the other alternatives, listed in Table 1, the Corps' assessment indicated that placement of hard structures (i.e. groins, revetments, etc.) along the Mid-Reach would probably not meet the desired objectives of the shore protection project. Groin field installation in this situation would most likely not provide beneficial effects but may actually exacerbate existing problems. Armoring such as revetment construction, would result in the loss of the beach and therefore, also does not meet project objectives. In addition to the problems posed by hard structures, it is generally considered that retreat from the shoreline by acquisition of properties would prove to be too expensive on a large scale.

Table 1. List of shore protection alternatives evaluated by the Corps in 2006.

1. No Action.
Allows the existing conditions to determine the future of the Mid-Reach shoreline. Expected future conditions involve continued erosion of the shoreline and probable loss of adjacent development.
2. Hard Structures
Hard structures are a last resort for most large-scale shore protection projects. However, a combination of hard structures may provide relief from on-going erosion along the Mid-Reach while minimally impacting sensitive hard bottom habitat along the shoreline. These solutions may be the most feasible options in areas with high rock density (the northern half of the Mid-Reach).
2a. Groins.
A group of either straight or T-head groins could be utilized to locally reduce the long-term erosion of the beach. The goal would be to 'hold the line' over the course of the project life to reduce the MHW line and berm/dune erosion that threatens upland development. This alternative could offer relief from erosion while potentially minimizing impact to the hard bottom resource.
2b. Revetments.
The construction of a rock or geo-tube revetment could provide long term erosion and storm damage reduction benefits, while not directly impacting the reef rock. This option, in the absence of periodic fill would likely result in little or no dry beach fronting the structures after a number of years.
2c. Breakwaters/Submerged Reefs.
Shore-parallel structures such as breakwaters or submerged reefs could be utilized to attenuate wave energy impacting the Mid-Reach and reduce erosion. These structures might also be utilized as part of the in-kind mitigation for reef rock impacts. Several scenarios were investigated including a perched fill behind the structures or a series of submerged breakwaters that alleviate long-term erosion in the area, i.e. reef balls adhered to reticulated concrete mattresses.
3. Beach Nourishment
Placement of beach quality sand in the dune or on the beach. The smaller density fills would be constructed with truck-hauled sand, the larger density fills would be hydraulically placed.
3a. Dune Fill.
Brevard County Mid-Reach beaches are not anchored by a traditional dune at their landward side, but by a relatively steep bluff that defines the upland from the beach berm. This bluff is at elevation 13-16 feet (NGVD). Beach fill in front of the bluff and above berm height (8.1 feet NGVD) could be placed to provide storm damage reduction benefits and provide 'feeder' material for the berm as it naturally erodes. This option would have minimal or no impact on the hard bottom resource.
3b. Beach Nourishment.
Beach nourishment alternatives will be developed for each reach (1 through 6) based on advancement of the MHW line in 20-foot increments to optimize shore protection benefits and project costs. The initial assumption regarding rock impacts is that 100% of the rock fronting any nourished beach will be covered and will require mitigation.
4. Retreat and Acquisition.
Vulnerable properties along the shoreline would be purchased thereby creating a buffer zone.

Description of the National Economic Development (NED) Plan:

The NED (referred to by the Corps as Alternative 19) consists of a 10-foot extension of the mean high water line plus advanced nourishment to maintain that design fill volume in Reaches 1; a 20-foot extension of the mean high water line plus advanced nourishment to maintain that design fill volume in Reach 2; a 30-foot extension of the mean high water line plus advanced nourishment to maintain that design fill volume in Reach 3; a dune with no added advanced nourishment in Reach 4; a 10-foot extension of the mean high water line plus advanced nourishment to maintain that design fill volume in Reach 5; and a dune fill with no added advanced nourishment in Reach 6. The fill will be accomplished by rehabilitating the Poseidon dredged material management area (DMMA) at Port Canaveral, dredging material from Canaveral Shoals with placement into the Poseidon DMMA, and hauling by dump truck to the Mid-Reach for placement on the beach at approximately 3 year intervals. The NED plan offers storm protection ranging from a 5-year storm level to a 75-year storm, varying along the length of the Mid-Reach. The plan includes 3.0 acres of environmental impact to the nearshore rock resources, following minimization of the impacts as much as possible while still offering maximum storm damage reduction. Project costs include mitigation for these rock impacts. The Corps determined that the NED plan offers the best solution, maximizing storm damage reduction benefits, while also minimizing environmental impact and maximizing the level of storm protection. Issues related to the fill material to be used for nourishment were evaluated earlier and are not part of this FWCAR.

Mitigation Plan:

Mitigation for impacts due to direct and indirect cover of the nearshore rock will be included in the project construction. The TSP includes impacts in Reaches 1 to 5 and no impact in Reach 6. The area impacted is on the landward edge of the nearshore rock, resulting in the small width of rock impacted but over the whole length of Reach 1 to 5. The calculated impact acreage is 2.9 acres out of the total of 33.66 acres of nearshore rock in the Mid-Reach study area. The nearshore rock seaward of the fill area will not be impacted. The mitigation quantity is calculated using a ratio of 1.6 mitigation acres required for every acre of natural rock impacted (CSA et al. 2006). As the impact quantity is 2.9 acres, the mitigation proposed will total 4.64 acres.

Mitigation Construction:

The preferred mitigation plan is the articulated concrete mats with coquina. The units are prefabricated concrete mats and can be connected to provide stability and contiguous habitat. The surface of each unit is imbedded with natural coquina stone that is similar to the natural rock in the area. The habitat relief is similar to the low-lying natural rock. The mitigation reefs will be placed seaward (approximately 300 m or 1000 ft) of the natural nearshore rock in water depths approximately 14 to 16 ft within the Mid-Reach study area. A safety buffer of 100 feet will be used around natural rock. Construction equipment is not capable of working from the beach and reaching past the nearshore rock, so Coast Guard approved barges will be used that can safely operate in the wave environment experienced in Brevard County. A crane will be used to lift the concrete mats from the barge and will place them into the water. Placement locations and construction costs will be further refined during the detailed analysis phase.

Potential Locally Preferred Plan (Tentatively Selected Plan):

The NED plan described above is the plan that maximizes the net benefits for the project area while minimizing environmental impact. In this case, the project sponsor decided that another plan is better suited to their needs, and the team will be required to abide by the current policy guidance regarding locally preferred plans (LPPs). If the LPP has a greater total project cost than the NED plan, the difference will be paid at 100% non-Federal cost. If the LPP has a lesser total project cost than the NED plan, the total project cost will be cost shared at the same percentage as the NED plan. All LPPs must have a cost to benefit ratio greater than one and be environmentally acceptable. The LPP was developed to satisfy concerns or desires of the project sponsor. This plan represents ideas that were not included previously as full alternatives, so offer additional insight. The LPP differs from the NED plan in Reach 3 where a 20-foot extension of the mean high water line and in Reach 4 where a 10-foot seaward extension would occur. The remainder is the same as alternative 19. The total nearshore rock impact for this plan is 3.0 acres. A similar mitigation plan as above is proposed with mitigation reef being proposed to compensate the 3.0 acre impact.

1.0 GENERAL ENVIRONMENT

The northern boundary of the Mid-Reach begins at the southern end of Patrick Air Force Base (PAFB) and extends south through the town of Indialantic Beach (Figure 1). Data from the recent studies (CSA 2005a & b; Dynamac 2005; Dial Cordy 2004) provide more detailed descriptions of the affected environment, as it relates to the ecology of fish, juvenile marine turtles, shorebirds, nesting turtles etc., and provide some insight into the environmental consequences of proposed shore protection options for the Mid-Reach area. Nearshore hard bottom and surf zone are included in the habitats that would be directly affected by the proposed Mid-Reach shoreline protection program.

Brevard County, located along the central east coast of Florida includes an extensive barrier island and estuarine lagoon system (Indian River Lagoon). The ocean shoreline is composed of sandy beach, vegetated dunes, barrier island strand, and maritime hammock. Access to the study area is by causeway from the mainland and by coastal highway State Road (SR) A1A.

Figures 2 and 3 show the relative proximity of coastal urban development to the project area and the fragmented coastal strand, the dune/beach zone and the rock reef.

Figure 2. Mid-Reach beaches of Brevard County showing the proximity of the rock reef resources to the human development along the coast.

Figure 3. Mid-Reach shoreline as viewed from the rock resources. (Courtesy, Dynamac, K. Holloway, 2005.)

Species composition varies within different areas of the beach with lower species diversity within the upper beach zone and an increase waterward (Greene, 2002). The Mid-Reach nearshore hard bottom habitat or "reef" is composed of coquina, Anastasia limestone, and worm rock outcroppings (Olsen Associates, Inc., 2003). Nearshore hard bottom and surf zone are the habitats that would be directly affected by the proposed Mid-Reach shoreline protection program.

The hard bottom habitat is most conspicuous along the shoreline from the south end of PAFB to the city of Indialantic (Figure 1). The description, mapping, and specific assessments of these rock outcroppings were described by Olsen (2003), CSA (2003, 2005a & b), and Dynamac (2005). The reef parallels the shoreline and is partially exposed in many areas at mean low tide. The reef structures exist predominantly in waters 0-4 m (0-13 ft) deep. The nearshore rock occurs in a narrow band immediately along and below the low tide shoreline at seabed depths of about +1 to -3 ft mean low water (about -1 to -5 ft ngvd). The rock extends up to about 280 feet from the mean low water shoreline along the northern Mid-Reach, and generally extends less than about 120 feet from the mean low water shoreline along the southern Mid-Reach (Olsen 2003). The water conditions over the structures are highly dynamic throughout the year; turbulent with high wave energy and normally poor visibility. Portions of the reef have been described as ephemeral; being covered and uncovered by shifting sands during typical surf and extreme tide and storm events. However, the macroalgal species found on some of these areas do not support the concept that these areas are "ephemeral". Sections of the nearshore reef in Brevard County are composed of "worm rock". These rock structures are formed by the reef-building sabellariid worm, *Phragmatapoma lapidosa*; originally described by Kirtley and Tanner (1968). Similar hard bottom habitats studied in Indian River and Martin Counties revealed that more than 300 invertebrates, 192 fish species, and over 100 marine algae species utilize the reefs and associated resources for development and survival (Nelson and Demetriades, 1992; Juett et al., 1976; Nelson, 1989). In addition to these taxa, federally listed marine turtles have also been found to utilize the rock resources (Ehrhart, 1992).

The creation of Port Canaveral in 1951, reversed the original southerly drift of sand along the Atlantic shoreline changing the water and wind pattern. Port Canaveral changed the natural littoral drift transport patterns along some sections of the central Brevard beaches and exacerbates natural current drift (Corps 1996). This aggravated erosion of the beaches south of the jetties and built up beaches to the north and was thought to reduce the sediment budget for the Mid Reach. Recently, sand by-passing was employed to transfer the amount of sand equivalent to that being blocked by the Port's jetties. A deficient remains for the years where no sand bypass to beaches south of the jetties occurred. The degree to which the Port contributed to the erosion of the beaches south of the jetty was studied by Olsen and Associates (2003). The study showed that the Port in fact does not likely impact the more southern areas from the Mid-Reach section and southward. The area is susceptible to storm surge and seas from tropical storms (August through early October) and nor'easters (late September through March). Both storm types have resulted in impacts that were relatively equally severe over the past few decades and varied annually in relative importance. The net storm effect is typically an erosional sloughing of the steep bluff and a vertical deflation of the beach berm in front of the bluff. The resulting recession of the bluff and loss of uplands is generally never recovered, while the berm partially or mostly recovers in most cases. Current loss rates range from one (1) ft per year at Melbourne Beach to 15 ft per year at Cape Canaveral (Olsen 2003). However, hurricanes and storms have seriously eroded dunes within the Mid-Reach. Several beach restoration and nourishment projects have been initiated by Brevard County and the Corps. Strong longshore drift and reversal patterns induce natural sand loss which then accretes to the south. The Corps' plan includes nourishment at varying intervals to maintain design template dimensions. Any new forthcoming design documents will require an amended FWCAR.

1.1 Upland dune /Dry beach zone

The Upland dune areas of Brevard County, previously described by the Service (1995) are present throughout the project area. They range from well developed dunes to weakly defined depending on location. Well developed dunes exist in the area north of Port Canaveral and closer to Sebastian Inlet to the south. Natural processes and human activities have severely impacted and reduced the original formations. These areas consist of dry sand beach above the MHWL, usually located 110-180 cm (3.5-5.8 ft) in elevation from the mean low water level. The highest and most xeric areas are characterized by a rapid loss of water and sharp temperature fluctuations. Shoreward, water is irregularly replenished through storms and high tides. Olsen (2003) reported the top of the dune/bluff face has retreated by about 0.6 ft (18 cm) per year on average along the Mid-Reach from 1972 to 2001 and the local rate was at least twice that value at some locations. The mean high water shoreline has retreated by about 0.3 ft per year (9 cm), on average. Overall, the measured bluff recession is poorly correlated with the shoreline changes. The severity of erosion along the Mid-Reach does not exhibit an apparent alongshore trend or chronic local "hot spots." Olsen (2003) also reported that neither beach profile data nor a numerical model study demonstrated any significant correlation between local beach erosion and the abundance of nearshore rock outcrops.

In 2007, most of the Mid-Reach is developed with residential and commercial structures and a few parks and access lots interspersed. Olsen (2003) reported 198 oceanfront property parcels along the Mid-Reach and approximately 3,560 ft of the Mid-Reach (9%) was armored by bulkheads or revetments, all located in Satellite Beach and Patrick Shores. Over 90% of the properties with habitable structures had setbacks of 100 ft or less from the top of the dune/bluff. By length, about 34% of the Mid-Reach oceanfront is either undeveloped property or property without habitable structures. The undeveloped proportion is highest along Satellite Beach (40%), and least along the southernmost 1.2-miles of the Mid-Reach (6%). This fragmented 7.78 mile shoreline includes 2 miles (3283 m) of discontinuous ocean front access through seven parks and several public parking lots. There are only three stretches of undeveloped beach front greater than 1000 ft (307 m) in length. The few semi-natural fragments remaining within the Mid-Reach are composed of coastal strand. There are much larger tracts of undeveloped but degraded and fragmented natural beach and dunes to the south of the project area in southern most Brevard County.

Typical vegetation of the coastal strand observed in the field in 2007 is similar to that described in 1995 (Service, 1995) and consists of open sandy patches mixed with sea oats (*Uniola paniculata*), dune grass (*Ammophila breviligulate*), sea rocket (*Cakile edentula*) cacti (*Opuntia compressa*), iva (*Iva imbricate*), pennywort (*Hydrocotle bonariensis*), croton, *(Croton punctatus*), sea purslane (*Sesuvium portulacustrum*), wild bean (*Stropphostyles helvola*) and morning glory (*Ipomodea purpurescens*). Private residences, built over the old coastal strand, support a large variety of non-native ornamental plants and grasses.

Fauna and wildlife known in this habitat type and specific area includes the raccoon (*Procyon lotor*), domestic and feral cats, domesticated dogs, threatened and endangered sea turtles, including the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill *(Eretmochelys imbricata*) and Kemp's ridley (*Lepidochelys kempii*) sea turtles. A detailed summary of sea turtle nesting densities, distribution and temporal variation within the Mid-Reach are described in the 2006 BO issued for the proposed Brevard County beach nourishment project (Service 2006, Appendix B). While loggerhead nesting to the south is considerably higher, the Mid-Reach supports very significant numbers of nests (2,643 nests in 2005), indicating the dunes accommodate approximately 800 nesting females.

This dune habitat could support the federally listed southeastern beach mouse (*Peromyscus polionotus niviventris)*, if human habitation were reduced. Fragmentation of this small mammal population is severe and the species has not been observed within the Mid-Reach. The American oystercatcher (*Haematopus palliantus*), Wilson's plover (*Charadrius wilsoni*), piping plover (*Charadrius melodus*), willet (*Catoptropphorus semipalmatis*), the laughing gull (*Larus atricilla*), gull-billed tern (*Sterna nilotica*), and Caspian tern (*Sterna caspia*) often use this habitat type (Myers and Ewel 1990), though Wilsons plover's have not been recorded according to the Brevard County Natural Resources Management Office (2007) and the FWC bird registry (2007). Snowy egrets (*Egretta thula*), great blue herons (*Ardea herodias*), and ospreys (*Pandion haliaetus*) are commonly observed. Scrub jays (*Aphelocoma coerulescens*), red shouldered hawks (*Buteo lineatus*), and several common song birds have been observed in the coastal scrub habitat in the past. The ghost crab (*Ocypode quadrata*) can be found throughout the project area in swash foredune and upland dune zones.

1.2 Swash Zone

The swash zone is found along the entire project and is composed of quartz sand, shell hash, coquina beach rock and rubble. This zone extends 90-110 cm (2.9ft-3.6 ft) in elevation from the mean low water level and is inundated by each tidal cycle but water circulates easily through the loose packed sand (Zottoli 1978). Sandy bottom beach sections are populated by small, short-lived fauna with high species density and substantial reproductive potential and recruitment.

Figure 4. View along the Mid-Reach across the swash zone down to exposed rocks and surf zone during low tide in 2005.

Nelson (1985) reported that haustoriid amphipods constitute (50-90%) of the fauna and contribute significantly to the total biomass with decapod crustaceans, bivalves, and spionid worms representing the remaining components of this community. Each of these occurs in relatively well-defined zones and depends to some extent on the nature of the substrate. Other species which dominate this area are the mole crab (*Emerita talpoida*), *Donax spp*. (coquina) and several polycheates (Nelson 1985, 1992). These species were observed during field visits in 2007.

Many birds mentioned from the dry beach zone utilize this zone and foraging on the crustaceans and polycheates described above. Birds such as the snowy plover are known to inhabit this zone Myers and Ewel (1990). In addition, the great blue heron, snowy egret and osprey were observed during field visists.

1.3 Surf Zone

The surf zone extends the entire length of the project area and extends from the mean low water level to 80 cm in elevation from the mean low water level. The sand remains saturated due to the constant submergence and inundation of the tides, allowing interstitial circulation of water throughout the sand. In contrast to the swash zone, here the increasing depth, finer sediments, and tightly packed sand inhibit water circulation (Zottoli 1978). Wave energy and exposure dictate the stability and diversity of the surf zone communities (Nelson 1985). Standardized baseline turbidity data along the Mid-Reach is not available but is described based on personal observations of visibility by divers. K. Holloway (Oct 2007) and D. Snyder (2006) indicate that diving visibility along the reef is poor (generally less than 2 ft) to occasionally good (3-6 ft). Visibility increases during the summer but is reduced significantly with tidal cycles and storms.

The occupants of sandy bottom in this zone are the same as for the swash zone. Species reported to occupy the surf zone are polycheates, echinoderms, amphipods, sand dollars, portunid crabs, penaid shrimp, bivalves, and small or juvenile fish.

Surf zone fish exhibit strong seasonality with few year round residents according to Nelson (1985). CSA (2005) reported 13 species from 10 families during their cast net samples. The false pilchard (*Harengula jaguana*) numerically dominated the samples (88%) and was followed in abundance by the Florida pompano (*Trachinotus carolinus*), kingfishes (*Menticirrhus littoralis, Menticirrhus* sp.) and the sand drum (*Umbrina coroides*). The false pilchard, an ecologically important member of the nearshore environment, occurs in schools of varying sizes and represents an important prey item for many reef and coastal pelagic fishes. Diving and wading birds are also known to feed on this fish. Herbivorous fish such as the Parrotfish (*Scarus coeruleus*), pinfish (*Lagodon rhomboides*), and damsel fish (*Chromis cyanea*) indicate that macroalgae is an important component of the community in these areas

CSA (2005) reported that the Mid-Reach surf zone fish (which, in this case, occupy a habitat surrounded by hard bottom) showed a species composition similar to other surf zone sandy areas away from hard bottom. The sheepshead and hairy blenny, (reef species) were exceptions found within the sandy areas of the surf zone where hard bottom habitat encroached. These data agree generally with the regional list for surf zone habitats by Gilmore et al. (1981). Species richness was generally low, with a few species accounting for most of the abundance, a common observation for surf zone ichthyofauna.

Over 80% of fish taxa collected in the Mid-Reach surf zone were represented by early life stages, either newly settled or early juveniles. Early stages included false pilchard, Florida pompano, gulf kingfish, kingfish, sand drum, white mullet (*Mugil curema*), and permit (*Trachinotus falcatus*). Early life stage species not represented were sheepshead (*Archosargus probatocephalus*) and dusky anchovy (*Anchoa lyolepis*). The dominance of early life stage fishes in the surf zone indicates the importance of this zone to the life cycles of local fishes. Although they have a regionally widespread distribution, juvenile gulf kingfish and Florida pompano tend to remain within local areas of shoreline and not make extensive migrations, indicating that local populations may be geographically restricted (CSA 2005).

1.3.1. Rock Reef Habitat within Surf Zone

Rock outcrops and scattered worm rock reef occupy the much of the surf zone of the Mid-Reach. The outcrops of coquina are Pleistocene remnants of coquina shell hash and sand lithified by a calcareous cement (Schmidt 1979) which provides substrate for the reef- building tube worm *(Phragmatapoma lapidosa*). In addition to the reefs themselves, individual nodules of worm rock are found growing in some areas of the coquina outcrops, primarily on the underside of ledges. This represents large sections of the nearshore reef in Brevard County. Interpretation of aerial photography and mapping were conducted in 2001 (Olsen 2003) and again in 2004 (Dial Cordy 2005). Additional assessments and epifaunal surveys were conducted over this hard bottom in 2005 (CSA 2005a & b, Dynamac 2005). The current estimate of nearshore rock in the Mid-Reach is 33.66 acres.

Hard bottom habitats contain greater species biomass and diversity than sand bottom habitats (Greene 2002). These habitats studied in Indian River and Martin Counties revealed more than 300 invertebrates, 192 fish species, and over 100 marine algae species depend on the reefs and associated resources for development and survival (Nelson and Demetriades, 1992; Juett et al., 1976; Nelson, 1989, Lindeman and Snyder 1999). The nearshore reefs support high densities of juvenile fishes in areas otherwise devoid of any substantial three-dimensional structural habitats. These habitats are important recruitment and nursery areas for a diverse marine fauna and flora, including rare taxa and important fishery species. For example, in the U.S., the striped croaker (*Bairdiella sanctaeluciae*) is limited only to nearshore reef formations of east Florida (EDO 2000).

Lindeman and Snyder (1999) suggested that nearshore hardbottom serves a primary nursery role for incoming early life stages of fish that would experience higher predation mortality without shelter. It may also provide secondary nursery habitat for juveniles that emigrate out of inlets towards offshore reefs. Some species use these structures as resident nurseries, settling, growing-out, and maturing sexually as permanent residents (e. g. pomacentrids, labrisomids). An additional nursery role may result from increased growth due to higher food availabilities in these structure-rich environments.

Nearshore reefs also provide important feeding and shelter areas for juvenile endangered green sea turtles (Ehrhart 1992, Dynamac 2005). The reef system is important for several reasons including the support of a stable and complex community of species and the modification and stabilization of beach sediments (Zale and Merrifield 1989, Wells 1970). It has been suggested that sabellarids may have been instrumental in the construction and preservation of beaches in the geologic past and that beach rock, converted from the reefs and impoundment of sediment on their landward side, provide for progradation of the beach (Kirtley and Tanner 1968). However, Olsen (2003) reported that the net importance of the reef based beach stabilization, so often characterized, and is not necessarily proven. He presented the findings of Dean et al. (1997) whereby submerged breakwaters could also destabilize the beach by effects associated with impounding water leeward of the reefs.

Gore et al. (1978) reported numerous invertebrate reef inhabitants to include amphipods, isopods, decapods, penaid shrimp, stomatopod, urchins, crustaceans including the porcellanid crab (Pachycheles monilifer), the zanthid crab (Menippe nodifrons) and the grasped crab (Pachygrapus transverses).

In 2005, CSA sampled fishes to specifically characterize the nearshore environment of the Brevard County Mid-Reach in anticipation of the proposed shoreline protection project. They reported that 88% of all individuals observed during swimming censuses were represented by just four species: black margate (*Anisotremus surinamensis*), hairy blenny, (*Labrisomus nuchipinnis*), silver porgy (*Diplodus argenteus*), and sheepshead. The most frequently observed species included hairy blenny, black margate, silver porgy, sheepshead, Atlantic spadefish (*Chaetodipterus faber*), and gray snapper (*Lutjanus griseus*). Other fishes were observed in the tidal sloughs that form during low tide along the landward margin of the hard bottom. The leopard searobin (*Prionotus scitulus)*, clingfish (*Gobiesox strumosus)*, and night sergeant (*Abudefduf taurus*) along the reef also contributed to the overall richness of the habitat. Macroalgae provide foraging and habitat value for the small crustaceans that are the primary food item for juvenile fishes.

The species composition along the Mid-Reach agreed with expectations for nearshore hard bottom off east-central Florida (Gilmore et al., 1981, Lindeman and Snyder, 1999). The striped croaker (*Bairdiella sanctaeluciae*) was the only species observed that is restricted to hard bottom areas of east Florida (Cape Canaveral to Jupiter Inlet) and due to this restricted distribution in Florida, it is a species of special concern (Gilmore and Snelson, 1992). CSA (2005) also observed a non-reef species, the gulf flounder (*Paralichthys albigutta*). While they generally occur over sandy bottoms of the region, during late summer and fall months, they migrate to shallow nearshore waters presumably to feed on abundant small fishes (mullet, pilchards, anchovies) concurrently moving through the area. CSA (2005) reported that fishes were present as juvenile or adult stages and no "newly" settled individuals were observed. The presence of small juveniles, particularly those of black margate and sergeant major, suggests that these species are settling here and not migrating from surrounding areas.

Juvenile sharks (*Carcharinus leucas, C. brevipinna, Sphyrna tiburo,* and *Ginglystoma cirratum)* were observed along the Mid-Reach by Dynamac (2005). They also reported captures of rays (*Aetobatus narinai* and *Rhinoptera bonasus)* and remora *(Remora* spp.).

Fish distribution varied along the Mid-Reach with generally higher numbers of species and individuals at the northernmost sites and progressively fewer along the shore in a southerly direction. Specific sampling sites that were species-rich (Sunrise Avenue in Reach 4 and Paradise Park in Reach 1) also had greater hard bottom areal coverage (Olsen 2003). However, CSA (2005) suggested that complexity in the form of undercut ledges and gulleys in the rock formations could be more important than overall aerial coverage in determining species richness.

The use of nearshore reefs as developmental habitat by juvenile loggerhead and green turtles has been recognized and studied in the Florida east coast counties of Indian River, Port St Lucie, Palm Beach, and Broward as well as the north gulf coast (Ehrhart 1992, Ehrhart al. 2001, Ehrhart et al 2002, Bressette et al. 1998, Quantum Resources 2000, Wershoven and Wershoven 1989). Due to the presence of the rock reef and associated macroalgae (figures 5 a. and b.) the Mid-Reach surf zone also provides habitat to juvenile marine turtles. In 2003, preliminary studies were begun on the marine turtles in this area by Holloway-Adkins (2005). Dynamac (2005) performed surveys with the express purpose of describing the relative abundance and distribution of turtles in the Mid-Reach as part of the SEIS. That study included visual transects and net captures of sea turtles. One species, the green turtle accounted for all but two sightings in 2004 and 2005 (those were loggerheads. Turtles were observed in very shallow water (<0.6 m, 2 ft) foraging, swimming and wedging themselves under rock ledges. Turtle sightings (0.41 turtles per km) were distributed relatively evenly along the northern 2/3 of the Mid-Reach (Corps segments 3-6). Figure 6 shows sightings were very infrequent at the southern end (Segments 1 and 2) where rock resources were very limited. The systematic turtle sighting data showed no strong correlation with the rock distribution other than at the southern end where sightings were negatively correlated. They suggested that turtles prefer substrates with abundant macroalgae and shelter which is minimal at the southern end (Reach 1).

The net capture data showed turtles were common along the Mid-Reach (Catch per unit effort (CPUE) of 2.47 turtles per net km) and were in good condition. The mean size (35.6 cm Standard Curve Length (SCL)) was similar to other east coast nearshore hard bottom sites. The food habit information for the green turtles indicated that they forage on a wide variety of algae found on the reef with red algae being the dominant type. Dynamac (2005) reported of the successful tracking of one juvenile turtle for a 2 week period during which the animal showed strong site fidelity as it stayed within about 0.5 km (1600 ft) of its original capture point.

Figure 5 (a. & b.). Photos of natural nearshore hardbottom of the Mid-Reach showing intact algal community. (Courtesy, Dynamac, K. Holloway.)

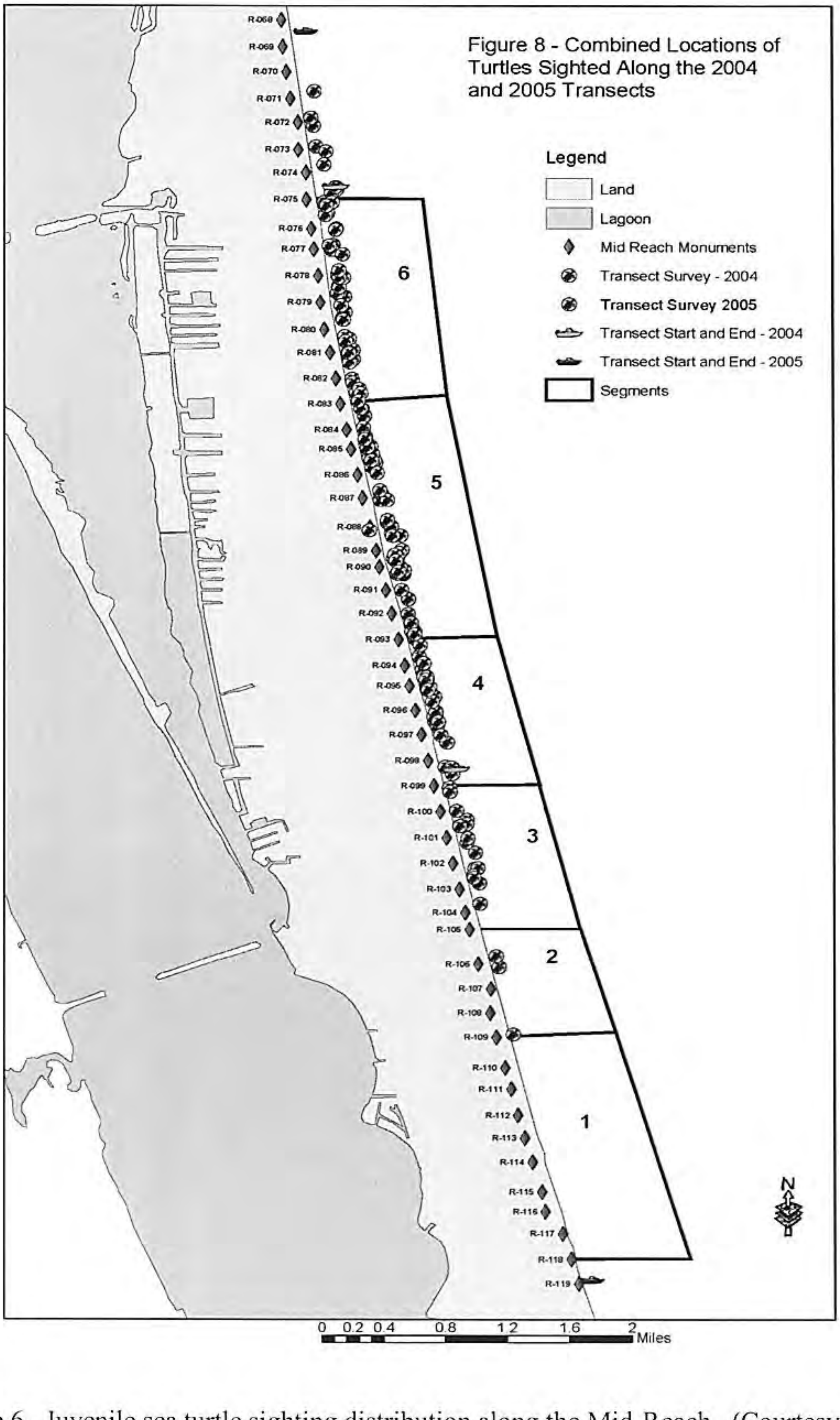

Figure 6. Juvenile sea turtle sighting distribution along the Mid-Reach. (Courtesy: Dynamac 2005).

1.3.2 Offshore Zone

The offshore zone begins where the surf zone ends and wave progression and energy is less impacted by the shore. Turbulence is generally reduced due to distance from the shore or reef breaks. The "near" offshore benthic habitat along the Mid-Reach consists of sand bottom (Olsen 2003). Biotic studies of the offshore, adjacent to the Mid-Reach have not been documented. More distant sampling of the offshore has been associated with bottom areas intended for borrow and dumping related to numerous historical and planned regional projects. Generally speaking, the area is described as having sandy substrate with a depth that slowly increases seaward and becomes a sandy-mud consistency as it extends toward the continental shelf. Sparse groupings of soft corals (Gorgonians) can be found along the sea floor and the benthic community fauna include squid, amphipods, jelly fish, annelids, bivalves, gastropods, crustaceans and scallops and bottom fish (grouper, flounder, sea bass, snapper, etc.). The offshore water column provides the necessary aquatic foraging and traveling environment for a multitude of species of fish that are both recreationally and commercially valuable. In addition it provides for the earlier mentioned sea turtle species. The offshore supports several marine mammal species (all of which are protected under the MMPA) and includes the endangered Right Whale (*Eubalaena glacialis*) and other protected smaller odontecetes (e.g. *Tursiops truncatus, Kogia breviceps*, etc.) and occasional manatees (*Trichechus manatus*).

2.0 Impacts

As described in section 1.3, the NED plan and the LPP will result in large quantities of sand deposition along the Mid-Reach over the existing beach front, into the surf over nearshore hardbottom to extend the beach out 10-30 ft beyond the current MHW line. The following describes anticipated impacts based on literature reviews of experimental studies, post construction surveys and discussions with experts.

2.1 Upland dune /Dry beach zone

As described in 2.1 this upper beach zone is comparatively limited in diversity and species richness and there are significant seasonal differences in these components. Beach nourishment will obviously place an overburden of sand on the dry beach zone. Fauna and plants unable to burrow through the sand will suffocate and die. According to Greene (2002) placing sediment/sand high on the beach allows gradual redistribution, giving motile organisms time to move away from the area or burrow up through the overburden. Large scale projects however, may not allow for rapid emigration and subsequent recruitment due to long distances from the undisturbed "source habitats". Further, densities of some communities may not allow for immigration without additional impacts.

Peterson et al. (2000) reported densities of *Emerita talpoida* (mole crabs) and *Donax spp*. (bean clams) were reduced by over 80% on North Carolina nourished beaches in July, 5-10 weeks after cessation of a nourishment project. Also about 3 months after termination of bulldozing, counts of active burrows of ghost crabs (*Ocypode quadrata)* were more than 50% lower on bulldozed beaches, with most of the reduction occurring on the 7 m of high beach occupied by the newly formed dune face. *Emerita talpoida* densities were more than 30% lower on bulldozed beach segments, while *Donax spp*. exhibited no consistent residual response to bulldozing. Peterson et al. (2000) suggested that failure of *Emerita* and *Donax* to recover from nourishment by mid summer when they serve as a primary prey base for important surf fishes, ghost crabs, and some shorebirds may have been a consequence of the poor match in grain size and high shell content of source sediments and/or extension of the project too far into the warm season.

Numerous sea turtle nesting studies have been conducted along the Florida coast and have resulted in specific guidelines related to beach nourishment. Details of sea turtle nesting densities and distributions are summarized the Service's BO for the proposed Brevard County beach nourishment project (Service 2006, Appendix B). Regulations in Florida do not allow for sand nourishment within the sea turtle nesting season, a time at which significant impacts would otherwise be experienced by these protected beach nesting species. While nourishment is not performed for biotic habitat improvements, properly designed and implemented nourishment can be beneficial to several taxa including birds, sea turtles and some beach plants that experience severe erosion of their historical habitat (NRC 1995, Service 2006).

The Mid-Reach project should be limited to the period of the year that does not include significant sea turtle nesting and incubation (May 1-October 1) thereby avoiding the majority of construction/operation associated impacts. (See Service, 2006, Appendix B for explicit recommendations.) No Wilson's plovers have been documented nesting along this beach; however, other plovers (non-breeding piping plovers) can be found here. Generally, nesting birds that might be found within the impact zone should likewise be protected by the schedule avoiding spring and summer season. The seasonal timing of the project associated with the previous mentioned taxa is a positive one relative to *Donax* and *Emerita* as well.

Additionally the project must utilize sand types consistent with requirements to match the local sand for grain size and color which effect permeability, compaction and temperature, etc. Effects of bulldozing on ghost crabs may be mitigated by measures to stabilize the dune face after bulldozing. Mechanical tilling and grading may also reduce compaction and scarping problems that inhibit normal excavation by the invertebrates as well as the nesting of sea turtles.

Mid-Reach specific sea turtle nesting surveys should continue for three years following the nourishment completion. FDEP requires a baseline and one year post project survey of shorebirds.

2.2 Swash Zone

The area between the edge if the nearshore rock formation and the beach known as the "Swash Zone" may affect larvae traveling from the lagoon or along the coast. Rapid benthic recovery of this zone following burial has been attributed to matching fill material with existing sediments and the placement of fill well above the mean sea level (NRC 1995). Dernie et al. (2002) described a large-scale field experiment that investigated the response of marine benthic communities within a variety of sediment types (clean sand, silty sand, muddy sand, and mud) to physical disturbance. The clean sand communities had the most rapid recovery rate following disturbance, whereas communities from muddy sand habitats had the slowest physical and biological recovery rates. They suggested that physical and biological recovery rates are mediated by a combination of physical, chemical and biological factors that differ in their relative importance in different habitats.

Greene (2002) reported that depth of sand of overburden, sediment composition, temperature and grain size will affect organisms in the intertidal and subtidal zone. Changes in the geomorphology and sediment characteristics may have larger impacts on recovery of invertebrates than direct burial. In a South Carolina study, several invertebrate species were found to be tolerant of sand overburdens and capable of burrowing vertically through 60 to 90 cm overburdens. Infaunal declines after beach nourishment were short term and followed by recoveries that range from rapid (2 weeks) to 7 months (NRC 1995). Quick recovery of this community was associated with ceasing nourishment actions before the infauna reaches seasonal low productivity (essentially leaving the recruitment window open for a longer period).

The Mid-Reach beach is composed of course (non clay/mud) and the project must utilize sand of matching character (tests by Olsen (2003) from the proposed donor site showed no significant difference from the current beach). Recommendations for reducing overburden impacts include matching nourished sediment to native sands as well as applying the sediments "slowly in a sheeting spray of water and sand". Infaunal studies suggest that sand overburdens should be no more that 60 cm. To increase swash zone infauna recovery rates, sand deposition should be completed or ceased prior to predicted natural infauna seasonal declines.

2.3 Surf Zone

The rock resources of the Mid-Reach are protected under Public Law 94-265, the Magnuson-Stevens Fishery Conservation and Management Act, as amended. Under the authority to protect EFH, the NOAA Fisheries has designated these rocks as Habitat Areas of Particular Concern (HAPC). This protection includes rocks with and without sabellariid worm colonization and live/hard bottom (depths of 0-4 m; 0-13 ft) off the east coast of Florida from Cape Canaveral to Broward County. Consequently, impacts to these EFH resources at the Mid-Reach must be minimized and mitigated. Corals, anemones, sponges, and macroalgae that colonize the hard bottom are sensitive to surficial sediment patterns which determine the composition and spatial distribution of the benthic communities (Greene 2002).

Burial of nearshore hard bottom during beach nourishment operations will alter the benthic environment significantly, covering invertebrate and macroalgal communities with their own unique microhabitats as well as the forage they provide to birds, fishes and turtles that are accustomed to this specific resource. Lindeman and Snyder (1999) found significant losses in fish abundance and distributions associated with hard bottom burial with a nourishment project in south Florida. Before burial, 54 species were recorded, with mean abundances of 38 individuals and 7.2 species per transect while after burial, only eight (8) species were recorded with mean abundances of less than one individual and species per transect. As described earlier, some fishes and the juvenile sea turtles appear to show some site fidelity. The potential for some of these nektonic animals to disperse from the area and resettle is possible but undocumented. Several challenging issues may arise during the nourishment impact period beyond burial of individuals and their forage including but not limited to predation (new sand habitat removing shelter over current "home-range") and exceeding carrying capacity (nearby sites assumed to absorb these animals are supposedly not impacted by nourishment but may not provide sufficient habitat for a simple distribution shift of these individuals, resulting in a cascading impact to populations in those outside areas.).

An unnatural and sustained increase in turbidity over the habitat is also of concern. Baseline turbidity data along the Mid-Reach is not available and so threshold values do not exist to guide construction action along this habitat. Visibility along the Mid-Reach appears to increase during the summer and is reduced significantly with tidal cycles and storms. An increase in turbidity can be cause by the construction method, if a containment berm is used to help settle fines into the berm during construction. These fines are then resuspended during profile equilibration. Turbidity increases at the nourishment site can also result from re-suspension of subsurface sediment deposits and from sediment winnowing from the nourished beach into the surf zone, which can be carried in the long shore direction or seaward with waves and currents (Greene 2002). The severity of re-suspension can be related to several factors including wave energy (more turbid during storms); amount of sand placed on the beach (more sand may increase turbidity); and the quality of the sand (higher content of silt/clay causes elevated turbidity (NRC 1995, Greene 2002).

Turbidity changes related to nourishment projects appear to vary. Greene (2002) reported that turbidity in the area of the outfall will usually disappear within several hours after nourishment operations cease and that over 90% of slurry discharged from pipelines settled to the bottom within several tens of meters from the discharge point. Studies conducted off the coast of New Jersey revealed short-term turbidity at the fill site was essentially limited to a narrow swath (less than 500 m) of beachfront. Dispersed sediment was most prominent in the swash zone in the area of the operation, with concentrations dropping off in the surf zone and nearshore bottom waters. Except for the swash zone, the concentration of sediment was considered comparable to conditions that might occur when sediment becomes re-suspended during storms (Corps, 2001a). Van Dolah et al. (1994) reached a similar conclusion; despite a maximum of 200 NTU confined to a narrow area, background turbidities were close to 100 NTUs during storms and normal fluctuations often elevated turbidity. In contrast, some studies of beach nourishment have found turbidity to be a persistent problem, reducing visibility seven years after project completion. Coral heads off the shore of Miami Beach were still dying 14 years after project completion, and another south Florida study recorded high turbidity and burial of nearshore rocks seven years later (NRC 1995).

In the review of such studies, Green (2002) reported that certain species may be positively affected by an increase in suspended sediment (i.e., a reduced risk of predation while foraging under turbid conditions). While there are species that may benefit from increased turbidity, there are also organisms that become stressed under these conditions (i.e. mortality of suspension-feeding benthic organisms and reduced foraging ability of animals utilizing sight to locate prey. Mole crabs suffered impaired feeding ability as a result of turbidity. Organisms that forage using vision might avoid these areas - for example juvenile greens. Wave tank experiments showed that turbidity caused a reduction in growth for filter feeding coquina clams. The Florida pompano reduced feeding on coquina clams and mole crabs, by 40% and 30%, respectively. It is possible that sessile species that occupy hard bottom reef habitats can be smothered by silt. Fish gills can become clogged, planktonic larvae of both vertebrates and invertebrates in the surf zone may be adversely impacted, filter-feeding mechanisms may become impaired, and photosynthetic activity may decrease (NRC 1995). Juvenile and small fish subjected to high sedimentation and turbidity can die from anoxia. Elevated sediment concentrations can also lead to egg abrasion and reduced ventilation rates in mollusks. Turbid conditions decrease light penetration, which can reduce primary productivity. When algal production decreases, motile species associated with attached macroalgae may have less available substrate. These effects can lead to changes in primary and secondary production, which, in turn, may cause substantial changes at higher trophic levels. Increased turbidity can have a number of physiological effects on marine life.

Baseline turbidity data (NTU) along the Mid-Reach should be collected for a reasonable period prior to construction. This has been the recommendation of numerous ecologists (NRC 1995, Greene 2002) but has yet to be accomplished. This will allow for more appropriate guidance during construction and assessing long term changes. It is not clear to what level turbidity will be elevated and for what duration. A recommendation is for standardized turbidity measures to be collected as soon as possible to provide baseline conditions along the Mid-Reach. This would include storm conditions, tidal variation and calm periods. Extrapolations could then be made incorporating local weather and buoy data.

The landward edge of the hardbottom in Reaches 1-5 will be adversely impacted through burial if the NED plan is approved. The LPP has less impacts than the NED Plan. The Corps acreage estimates yield hardbottom loss of approximately 8.4%. The NED plan and the LPP are clearly based on numerous iterations of options to reduce impacts to the hardbottom and associated fauna and flora by limiting the waterward extent of sand over Reaches 6 through 3. The LPP, however, includes larger quantities within Reach 1 and part of 2, increasing the impact zone. Assessment of post burial or remaining hardbottom distributions would be recommended after dune nourishment. This would establish the new baseline of remaining hardbottom along the Mid-Reach. Relative densities or cover of the benthic community (macroalgal, *Phragmatapoma* and key invertebrates*)* should be assessed post construction and monitored for a period of at least 2 years.

Based on Lindeman and Snyder (1999) and discussions with NOAA Fisheries (G. Getsinger, 2007), the impacts on juvenile and larval fishes occupying the 7.6 miles of Mid-Reach surf zone may be significant. NOAA (2005, see Appendix) identified issues of concern related to this project and determined an adverse effect would result based on 2005 planning. The habitat is designated by NOAA as an EFH and a HAPC. While some of the fish species in this community are designated by NOAA for protection, none are listed by the Service. Nonetheless this community provides a significant and unique ecological function along the Florida coast. The majority of the non-motile cohorts at the time of the project would be destroyed. The services provided within the burial zone will be lost due to the first construction and all subsequent maintenance projects. It is not clear that motile species, including larval fish, residing along the Mid-Reach at the time of construction would be capable of dispersing or relocating themselves to the proposed mitigation reefs located 300 meters to the east. (More details below under Mitigation Reef).

If in the future, an adequate, functional mitigation reef is proven to compensate for the above losses, consideration should be given to the development of temporary paths or corridors of hardbottom-like material from the seaward side of the impacted nearshore hardbottom out to the mitigation reef. If it is physically and fiscally possible to emplace a series of paths, these might improve survivability of the fishes, invertebrates and others attempting to disperse during construction.

In terms of juvenile sea turtles, the NED plan and LPP propose to minimize sand extents in the segments (6-2) which support numerous juvenile sea turtles based on 2004-2005 surveys. This minimized design is supported by the Service. If an approved mitigation reef is constructed to compensate for lost habitat described above, then monitoring of fish and juvenile turtle populations along the impacted nearshore hardbottom is recommended for a period of 2 years after nourishment of the Mid-Reach. This would include sampling within the Mid-Reach as well as adjacent natural hardbottom (to the north) that may become indirectly impacted as a redistribution sight for displaced animals. (Similarly the mitigation reef habitat should also be monitored for successful recruitment at several trophic levels including *Phragmatapoma*, key invertebrates, algae, fish and juvenile sea turtles.

2.4. Offshore Zone

The offshore zone may be impacted by turbidity increases associated with increased sand dispersion. The sand is expected to be relatively contained over the surf zone and nearshore hard bottom. If sand escapes as the beach tends toward equilibrium, then turbidity will increase for a period of time that is predicted to be short if the proper sand matches are made to the local environment. Additionally the zone would be considered impacted by the project primarily if the mitigation reef is approved as it is proposed to be located within this zone (300 m east of the nearshore hard bottom).

The impact to the offshore zone by the proposed reefs would be considered acceptable. It is open sand which is considered an extremely abundant environment and capable of absorbing this change that will include an attraction of flora and fauna. Placement of the artificial reef over this habitat would not be considered a significant negative impact to this habitat type.

2.5. Mitgation Reef:

The Mid-Reach project includes the creation of a mitigation reef placed in approximately 12 to 14 ft of water just east of the Mid-Reach. It is described in section 1.4 and figures 7 and 8 provide diagrams of the plan. Based on recent studies, the proposed materials will provide substrate and structural complexity that is likely to attract fauna and flora. This proposed reef includes a primary departure from natural conditions of the current nearshore hardbottom; the departure being depth and its associated lighting and temperature characteristics. While some of the nearshore hard bottom does include depths of 12 ft, much of it is considerably shallower (< 3 ft). Based on current technology described by the Corps and Brevard County, the reef cannot be placed in the shallower waters or over the planned burial areas and must be placed approximately 300 m to the east. There are no examples, to date, of artificial reefs that successfully provide proper mitigation for such projects along the east coast (G. Getsinger/NOAA, personal communication).

Lindeman and Snyder (1999) evaluated a similar nearshore impact in south Florida; however the mitigation reef was not constructed until three years after the renourishment occurred. Many factors can limit net biomass productivity. However it was concluded that if the artificial reefs were constructed prior to burial of the natural reef and located at similar depths, mitigation reefs may have provided a refuge for a sizeable fraction of the thousands of displaced fishes during the burial of that hardbottom reef, as well as thousands of subsequent new recruits. This study emphasized the importance of depth and timing. The timing of the construction of the mitigation reef is critical due to the distance of the mitigation reef to the nearshore hard bottom reef impacted. The mitigation reef must provide an established refugee habitat similar to the impact area prior to burial of the nearshore hardbottom to reduce predation from fleeing juveniles during the impact event.

In 2006, a study of a mitigation reef and nearshore hard bottom was conducted in nearby Indian River County, Florida (CEG 2007). The first annual monitoring report described the Ambersand artificial mitigation reef with limited results in terms of applicability to the Mid-Reach. That reef was also placed in deeper environs. The study was to assess high relief (HR), low relief (LR) mitigation reefs and natural nearshore hard bottom. The phased placement of the mitigation reef, in 2004 and 2005, allowed for some comparison of the effects of the 2004 hurricanes on benthic succession and fish populations over the IRC natural hard bottom. However, visibility was reduced by the 2004 hurricanes and impeded collection of the benthic data. Benthic data in 2007 and 2008, in the absence of major hurricanes, is anticipated to better evaluate differences in the benthic habitat quality between the natural nearshore reefs and the mitigation reefs. The 2006 data showed that mud deposition appeared to have a greater effect on benthic succession and composition than the difference in vertical relief between the two mitigation reef types. Overall, the benthic community on the high-relief reef (constructed in 2004) appeared to be in the earlier stages of succession compared to the 2005 constructed reef due to the relatively high cover of silty sediment and mud over hard substrate. Percent cover of macroalgae (24.5%) and species diversity was significantly higher at the HR reef placed in 2005, than the remaining transects. The second highest percent cover of macroalgae (10.8%) was also observed at a 2005 LR reef.

As for fishes, CEG (2007) reported that the IRC reefs appeared to enhance the fish abundance on the nearshore hard bottom. The mitigation reefs (LR and HR) had significantly higher relative abundance of fishes than nearby natural nearshore hard bottom of similar water depth and vertical relief. Fish assemblages between mitigation reefs and natural nearshore hard bottom were not significantly different however, data from artificial reefs document an increase in certain predatory fish species, such as tom tate and grunts. This increase in predatory fish could affect juvenile fishes that would occur on the natural reef. Similarly for new mitigation reefs in 2005 (HR vs. LR) relative abundance of fishes was not significantly different, but fish abundance was significantly higher on the HR mitigation reef placed in 2005 than the HR mitigation reef placed in 2004. They suggested this supported the negative impact of the 2004 hurricanes on fish assemblages on the mitigation reefs placed prior to the storms. They suggest that the mitigation reef placed after the 2004 hurricanes experienced superior recruitment and subsequent site fidelity which enhanced fish abundance and richness in the nearshore area. CEG (2007) reported that the habitat complexity and rugosity of the mitigation reefs (HR and LR) was superior to the natural nearshore hard bottom and strongly enhanced the fish abundance. Several schools of larger predatory fish, e.g. Snook (*Centropomus undecimalis*) and Snapper (*Lutjanus sp.*) were observed in the vicinity of mitigation reefs which could affect the survivability of the juvenile fish. The larger predatory fish. This community structure (size composition, etc.) is not similar to the nearshore hard bottom. They noted areas with high cover of oysters (*Crassostrea virginica*), associated with large schools of Sheepshead (*Archosargus probatocephalus*) indicating a relationship between food type/availability and richness/abundance of fishes. Relative abundance of juvenile and recruit stage fishes was not statistically significantly higher on the IRC mitigation reef as compared to the natural nearshore hardbottom sites.

In 2006 and 2007, two recruitment studies of small artificial test reefs for the Mid-Reach were conducted. The test reefs were placed at the projected depth (4.6 m, 15 ft) and general location of the proposed Corps/ Brevard County mitigation reef site (McCarthy and Holloway 2007, Holloway and McCarthy 2007). They utilized submerged limestone, concrete, coquina and a coquina-concrete mix as the reef substrates to assess biotic settlement with specific interest in worm (*Phragmatapoma*) and algae recruitment. For the worm recruitment studies they also assessed limestone plates to test for variations caused by height, orientation and chemical induction of larval settlement.

They observed that *Phragmatapoma* and numerous macroalgae and several invertebrate species recruited to all of the test plates on the reef. The macroalgal recruits were the same as those identified in the diets of juvenile green turtles captured over the adjacent nearshore reef by Holloway and Provancha (2005). The algal species recruited fairly quickly, within 141 days, and percent cover of total, green or red macroalgae remained consistent regardless of the substrate. *Phragmatapoma* recruitment varied between the two sampling periods (spring/summer 2006 and summer 2006/spring 2007), suggesting differences may have been related natural seasonal fluctuations in larval availability. They also found that *P. lapidosa* larvae recruited successfully regardless of the effect of test reef orientation, height and chemical treatment.

Based on results from recent studies, discussions with Corps planners, and local biologists, there is merit for the construction of artificial reefs to mitigate for anticipated losses of *Phragmatapoma* and macroalgae of natural hardbottom along the Mid-Reach. However, none of the pertinent studies indicate a full understanding of the long term impacts of losses of the natural nearshore (shallow) hardbottom. The extent to which the mitigation reefs provide for the same productivity and age class structures for various taxa, particularly fishes, remains to be determined. Fish assemblages and life stages are repeatedly mentioned as differing significantly between natural hard bottom and artificial deeper water mitigation reefs. The spatial scale of the biological impacts is also unknown. These issues continue to be raised with many nourishment projects and are followed by recommendations to improve knowledge of federal beach nourishment impacts to the nearshore environment (Greene 2002, NRC 1995, Lindeman and Snyder 1999, CSA 2002, Peterson and Bishop 2005, and G. Getsinger/NOAA personal communication). To date, serious questions remain about realistic mitigation for the loss of such a unique habitat.

It is recommended that the mitigation system (figures 7 and 8) proposed by the NED plan and LPP be further evaluated for the above mentioned attributes prior to approval. The results would be re-evaluated and recommendations made. Interim recommendations include:

1. It is not clear what the acreage estimates represent. Areal coverage interpreted from aerial photographs may miss the important physical attributes of the nearshore reef. If it is truly areal extent, then a more accurate estimation of hardbottom extent beyond areal coverage is recommended (e.g. estimating surface area and density associated with the complexity of the natural hardbottom to ensure mitigation size is adequate).

2. The impact to the proposed sand bottom location for the proposed reefs would be acceptable. It is open sand bottom which is considered extremely abundant but relatively sparsely populated. Placement of the reef over this habitat would not be considered a significant negative impact to this habitat type.

3. It is recommended that the reefs be deployed near the time, but in advance of the nourishment action to provide immediate access for "fleeing", dispersing, and recruiting organisms. Previous east coast projects experienced delayed mitigation reef placement which provided no timely refuge for these organisms and complicated monitoring results.

4. If approved, the mitigation reef habitat should be monitored for successful recruitment at several trophic levels and taxa (including *Phragmatapoma*, other key invertebrates, algae, and appropriate species and life stages of fish and sea turtles). This sampling should be conducted for a minimum of two years. Sampling design should be robust enough to provide adequate quantitative analyses. Sampling should be coordinated with stations designed to similarly monitor changes over the buried hardbottom and the adjacent unburied hard bottom including that to the north of the project boundary. This northern hard bottom may be impacted by immigrating organisms attempting to disperse away from the nourishment/burial areas. This potential cascading impact should be monitored.

5. If approved, the mitigation reef habitat should also be monitored for successful nesting, feeding, nursery, and shelter areas and a comparable replacement in function of the undercut ledges and gullies in the nearshore hardbottom impacted.

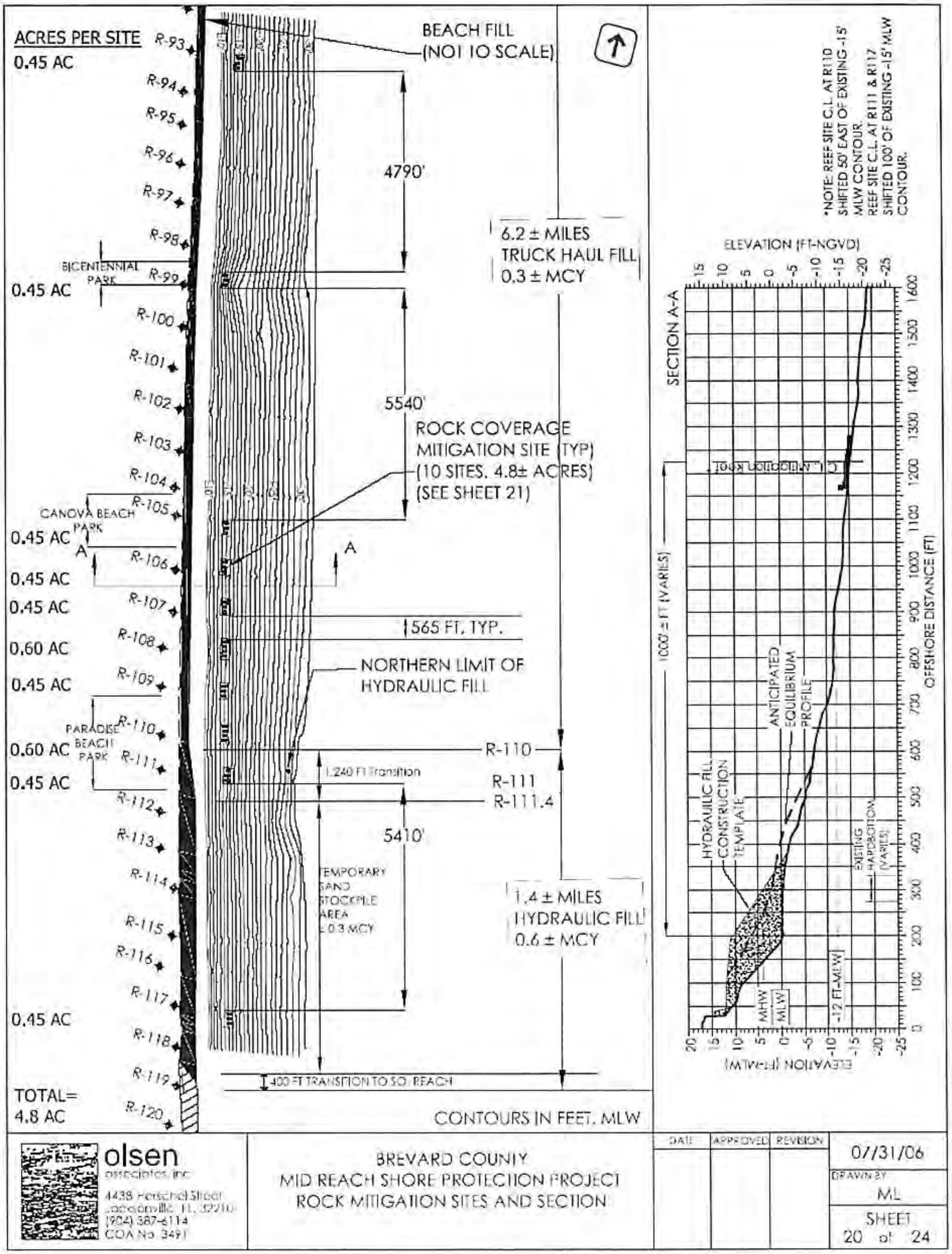

Figure 7. Location of mitigation sites for the nearshore hard bottom losses along the Mid-Reach. (Courtesy Olsen Associates, Inc. 2007).

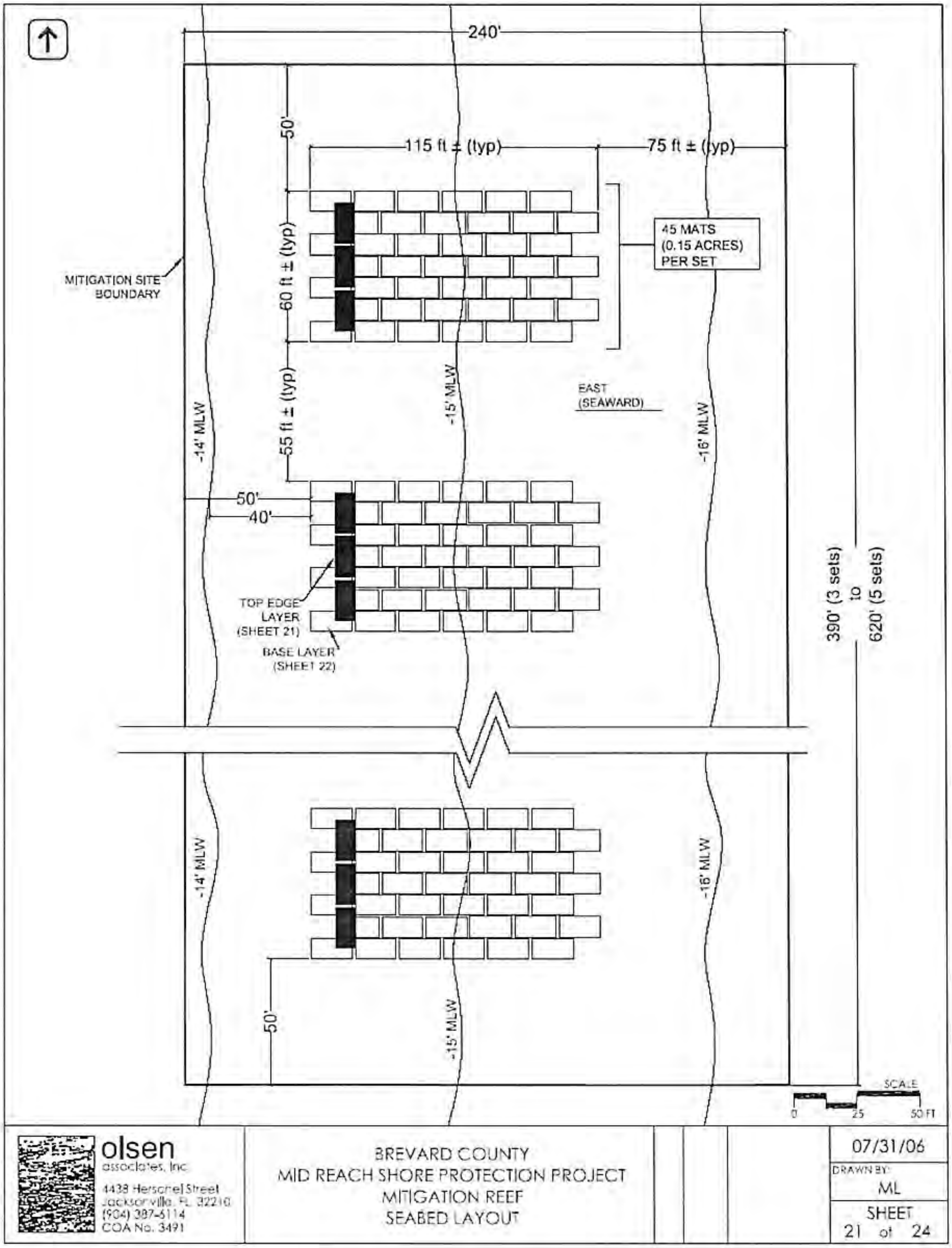

Figure 8. Mitigation reef design as proposed for the TSP and LPP for the Mid-Reach impacts. (Courtesy Olsen Associates, Inc., 2007)

3.0 RECOMMENDATIONS

In developing the Service's Mitigation Policy (Federal Register 46 (15), January 23, 1981), the Service used the definition of mitigation contained in the Council on Environmental Quality's National Environmental Policy Act regulations (40 CFR Part 1508.20[a-e]). By definition, mitigation can include: (1) avoiding the impact all together by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree of magnitude of the action and its implementation; (3) rectifying the impacts by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (5) compensating for the impact by replacing or providing substitute resources, or environments. This definition recognizes mitigation as a stepwise process that incorporates both careful project planning and compensation for unavoidable losses and represents the desirable sequence of steps in the mitigation planning process.

Initially, project planning should attempt to ensure that adverse effects to fish and wildlife resources are avoided or minimized as much as possible. In many cases, however, the prospect of unavoidable adverse effects will remain in spite of the best planning efforts. In those instances, compensation for unavoidable adverse effects is the last step to be considered and should be used only after the other steps have been exhausted. The Service's Mitigation Policy focuses on the mitigation of fish and wildlife habitat values, and it recognizes that not all habitats are equal. Thus, four resource categories, denoting habitat type of varying importance from a fish and wildlife resource perspective, are used to ensure that the mitigation planning goal will be consistent with the importance of the fish and wildlife resources involved. These categories are based on the habitat's value for the fish and wildlife species in the project area (evaluation species) and the habitat's scarcity on a national, regional or local basis. Resource Category 1 is of the highest value and Resource Category 4 the lowest. Mitigation goals are established for habitats in each resource category. The mitigation goal for Resource Category 1 habitats is no loss of habitat value since these unique areas cannot be replaced. The goal for Resource Category 2 habitats is no net loss of in-kind habitat value. Thus, a habitat in this category can be replaced by only the same type of habitat (i.e., in-kind mitigation). The mitigation goal for Resource Category 3 habitats is no net loss of overall habitat value. In-kind replacement of these habitats is preferred, but limited substitution of different types of habitat (out-of-kind mitigation) perceived to be of equal or greater value to replace the lost habitat value may be acceptable. The mitigation goal for Resource Category 4 habitats (considered to be of marginal value) is to avoid or minimize losses, and compensation is generally not required.

The nearshore hard bottom of the Mid-Reach represents a unique habitat of very limited quantity along the Atlantic coast. It is considered a priority "resource" within the project area supporting the epibenthos, macroalgae, invertebrates, turtles, fishes, birds and recreational fishers. Loss of important foraging habitat in the project area could result in increased intraspecific competition on remaining natural habitats if juvenile greens are displaced from foraging sites. Key ecological services provided by nearshore hard bottom include substrate, shelter, habitat connectivity, feeding sites, nesting sites, and nursery areas. This resource and the associated species in their appropriate life stages are considered by the Service to be in Resource Category 1, and no loss of habitat value of these unique and limited areas is recommended. The Service recommends that the following measures be included in future project planning:

1. While the Corps performed significant detailed analyses of alternatives and improved the understanding of some components of the nearshore hard bottom, certain data are still lacking. Further study of the ecological services that result from the proposed mitigation reef (placed in 12-16 ft of water, 300 m from the planned nourishment and hard bottom burial area) will improve our assessment of the risk of destroying the limited and unique resource known as the Mid-Reach hard bottom. Existing studies utilizing a mitigation reef for this unique habitat have been restricted to settlement rates of macroalgae and *Phragmatapoma*. While these resources have shown positive response to the proposed design, settlement of specific fish and invertebrates of the appropriate life stages have not been sufficiently evaluated.

2. A long-term monitoring strategy should be created prior to the first nourishment event. This long-term monitoring strategy should focus on the direct, indirect and cumulative impacts of the nourishment on the nearshore hard bottom ecosystem.

3. If the study of a deployed reef (such as described in the Corps plan) results in matched function and value as compared to the natural nearshore hard bottom then, a mitigation reef system would be recommended. It would also be recommended that the reef be prepared well in advance of the project construction, and at least half of that acreage should be deployed before construction to provide refugia for fishes and motile invertebrates which may be displaced by the project.

4. The resource agencies should conduct a meeting with the information received on the portion of the mitigation reef that has already been deployed. Monitoring just after completion of the nourishment event and in the short term should be designed to analyze the actual area of direct and indirect impacts of short-term habitat and functional value. If the proposed mitigation reef did not in fact mitigate for the loss of the nearshore hard bottom over the short term, an alternative mitigation plan should be discussed.

5. The resource agencies should conduct a meeting with the information received after long-term monitoring of the nearshore hard bottom and the proposed mitigation reef. If the monitoring demonstrates that the mitigation ratios are no longer valid with the new information received, an alternative plan should be discussed to mitigate for the loss of the habitat and functional value of the nearshore hard bottom.

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Appendix A

Brevard County, Florida Storm Damage Reduction Project
Mid-Reach Segment
Interagency Meeting
June 13, 2007
U.S. Army Corps of Engineers Office

Meeting Minutes:

1. The following were in attendance:
   - Kevin Bodge, Olsen Associates, Inc.
   - Virginia Barker, Brevard County
   - Mike McGarry, Brevard County
   - Karen Holloway-Adkins, East Coast Biologists
   - Ann Marie Lauritsen, USFWS/Jax FO
   - John Milio, USFWS/Jax ES FO
   - Jason Engle, USACE, Jax District
   - Candida Bronson, USACE, Jax District
   - Paul Stodola, USACE, Jax District
   - Kenneth Dugger, USACE, Jax District
   - Irene Sadowski, USACE, Jax District
   - George Getsinger, NMFS HLD
   - Osvaldo Rodriguez, USACE, Jax District
   - Jessie Pettingill, USACE, Jax District

The following were in attendance via telephone conference call:

- Marty Seeling, Florida DEP
- Steve MacLeod, Florida DEP
- Doug Weeks, Florida DEP
- Kaitlin Luskin, Florida DEP
- Jackie Larson, Florida DEP
- Vladamir Kosmynin, Florida DEP
- Dennis Klemm, NMFS
- Pace Wilber, NOAA Fisheries
- Robbin Trindell, FFWCC

2. Osvaldo Rodriguez welcomed everyone to the meeting and introductions were made. Candida Bronson and Paul Stodola gave a short powerpoint presentation based on the read-ahead materials and then opened up the floor for discussion.

3. Robbin Trindell opened up the discussion by asking which models were used to predict equilibration and if they were the same as in non-rock areas. The concern was if the rock impact presented was reasonable or if it underestimated the impact. Jason Engle explained how the rock impact was calculated, by using historical data from the Mid-Reach and translating the profile seaward. This approach assumes that the natural slope of the shoreline would be translated seaward with the addition of material. Kevin Bodge

added that with the small amount of fill proposed, this is a valid approach. He added that fills at Patrick AFB can be used as a case study. Data from the Patrick AFB project have shown a stable fill, with longshore movement of material essentially in balance between what is moving north and what is moving south. **It was requested that a summary of the Patrick AFB project and monitoring results be included in the next documentation for the Mid-Reach project.**

4. A concern was stated about turbidity impacts to the nearshore rock. Clarification resulted in the concern being not only the physical burial of rock but the impact on adjacent rock by turbidity caused by the fill. This would occur at every renourishment. Kevin Bodge stated that the material proposed was very low in fines content and is not expected to cause a turbidity issue. **Information on the borrow material will be provided in the next set of documentation.**

5. Ann Marie Lauritsen turned the discussion to the mitigation and monitoring plan. The monitoring plan in the read-ahead material discusses physical and biological monitoring over a period of 5 years. Provisions are included for actual versus predicted losses. A question was asked if the permits can include a requirement to recalculate the amount of mitigation based on the monitoring data of impacts. Marty Seeling stated that there is precedence for this, and additional mitigation is usually required at the next renourishment.

6. A technical question on the UMAM calculation was directed to DEP. Paul Stodola had used the technique of applying a zero to the post-burial rock area and a zero to the sandy bottom prior to construction of the mitigation reef. Marty Seeling agreed that this was appropriate.

7. George Getsinger asked if any studies were completed of the effects on the rock within the Mid-Reach following the Patrick AFB fill. Kevin Bodge stated that the Patrick AFB fill has been relatively stable, except for the 2004 hurricanes when a loss of material was noted. The material did not visibly migrate north or south but was lost to the project. Monitoring was done for about a ½ mile south into the Mid-Reach area. Generally the Mid-Reach rock coverage is the same as historical amounts with no noticeable impact from the Patrick AFB fill. The rock is highly variable through time, with certain outcroppings buried while others emerge, but generally the same amount of rock is exposed through time. This is also variable with seasons and storm events.

8. The discussion moved to the topic of functional loss versus functional gain with respect to the rock impact and the mitigation proposed. Marty Seeling expressed reservations regarding the deeper depth of the mitigation reef compared to the shallow impact area. He did acknowledge that it may not be possible to verify if every function exists in both places and that best professional judgment may be used on the appropriateness of the mitigation. Karen Holloway-Adkins added some information from the environmental studies, stating that it was estimated that 64-85% of the function of the natural rock will be replicated by the mitigation reef. Concern was expressed over lost functions and cumulative effects. Virginia Barker added that out of the 7 sub-sets of functions studied, all were present at the mitigation site. George Getsinger suggested that the studies are missing specific age classes that may be affected. Ann Marie suggested

that some of the concerns could be addressed through the monitoring plan. The monitoring plan should be tailored to address the uncertainties in the project and allow for adjustments in the mitigation required.

9. The Indian River County mitigation project was brought up as an example of mitigation in the same 14 to 16 foot water depth. The monitoring report was just published for review. Vladamir Kosmynin and Robbin Trindell had looked at the report and offered that there was no baseline data where the natural rock was studied before impact, so that study does not answer all of our questions. It was stressed that the monitoring plan for Brevard Mid-Reach needs to contain a pre-construction survey of the impact area. Several others had not had the opportunity to review the report. **Candida Bronson offered to get an electronic copy from Brevard County and make available.**

10. In a broad sense, Robbin Trindell said that the presented plan appears to be the right alternative. Concerns now focus on the mitigation and monitoring plan. George Getsinger seconded that idea. The monitoring plan needs to include baseline studies, the impact area and adjacent areas and include both physical and biological monitoring.

11. George Getsinger asked about the Port Canaveral sand bypassing project and how that might affect the Mid-Reach project. In particular, what are the effects of placing a large volume of sand at one time rather than annually? Jason Engle stated that several studies have shown that the volume of sand is appropriate and that effects to the Mid-Reach have not been shown. Since the initial construction of the North Reach project, there is plenty of sand to feed the longshore littoral drift, so no further impacts should occur. Kevin Bodge added that monitoring of the fill placement from the bypassing project has shown the same annual longshore transport regardless of the timing of the bypassing, i.e. the transport volume is the same in year one as in year six. So it appears that there is no effect on the transport of sand south by placing a large volume every six years as opposed to a smaller volume every year.

12. It was asked for a briefing on the PALM study. Karen Holloway-Adkins provided the briefing and status. Three modules were constructed and deployed for the purpose of studying recruitment of sabellariid worms and macroalgae on different substrates. Following 44 days in place at 15 foot water depth, one of the modules was pulled out of the water on May 5th. Dr. McCarthy of Jacksonville University is still studying the samples and a report has not been compiled yet. From observations, Karen stated that there had been some scour and burial of the modules, and that there was good recruitment and diversity of macroalgae. The bottom line was that both the sabellariid worm and macroalgae were recruiting at the deeper depths.

13. Paul Stodola initiated further discussion into the UMAM calculations. In particular the risk factor has a big impact on the final mitigation ratio and is under question. The Corps of Engineers is presently using 2.0 in its draft UMAM. Marty Seeling said it may be that a factor over 2.0 is appropriate. His main concerns are over structural stability of the mitigation reefs and the appropriateness of the mitigation reef design. It was suggested that some of these concerns may be addressed in the monitoring plan. For example, subsidence or other change in the physical size of the mitigation reef is easily monitored and conditions of the permit could require more mitigation. The

appropriateness is a more difficult question. However, the point was raised that requiring more mitigation of a type that may not work is not any better. The baseline data collection was mentioned again as a requirement in determining if the mitigation is working to replace the lost functions or not. FDEP stated they are generally happy with the studies done to date. **All available data to date from the Brevard County environmental studies needs to be included in the next document.** The monitoring plan needs to include specifics with a schedule, cost and parameters to be studied. It should be multi-season, include some species-specific studies, and age and depth related parameters.

14. George Getsinger asked about the non-structural measures listed in the read-ahead material and if any of them proved to be a viable alternative to construction. The read-ahead contains descriptions of several non-structural measures and qualitative evaluations of why each of them do not fully address the problems at the Mid-Reach. No non-structural measures were included in the final array of alternatives. The condemnation and acquisition measure was carried forward to identify parcels for acquisition but proved to be an incomplete solution due to the high variability of structure age, design, and set-back from the shoreline. Other policy changes are difficult to implement as the Corps does not have jurisdiction and local authority is variable, some Brevard County, some City of Satellite Beach, and some City of Indian Harbour Beach.

15. Summing up. Robbin Trindell and George Getsinger voiced their support. A lot of progress has been made on this project, the alternatives evaluation was very thorough, and the team is headed in the right direction. Ann Marie Lauritsen added that the team has shown avoidance and minimization of impacts, acknowledging there is still work to be done on the mitigation and monitoring plan. Marty Seeling commended the Corps for the work completed and agreed with Ann Marie on the work needed for the mitigation and monitoring plan. John Milio and Irene Sadowski agreed also. The Corps had invited the agencies to participate in the study as "collaborating agencies" and NMFS and USFWS have accepted. **George Getsinger and Ann Marie Lauritsen offered to work directly and informally with Paul Stodola to help develop the monitoring plan.**

16. The next steps for the project were summarized as presentation of the proposed plan to Corps headquarters at the AFB meeting in late August or September followed by preparation of the draft report. Brevard County and all the environmental resource agencies will be invited to the AFB meeting and documentation will be made available. The purpose of the meeting is to get approval of the proposed plan. It is likely that the monitoring plan will not be complete at that time but will be completed prior to the draft report.

17. The meeting was adjourned at 12:25 pm.

Appendix B

USFWS 2006 Biological Opinion with amended Reasonable and Prudent Measures and Terms and Conditions

Colonel Paul L. Grosskruger, District Engineer
U.S. Army Corps of Engineers
Regulatory Division, North Permits Branch
Atlantic Permits Section
P.O. Box 4970
Jacksonville, Florida 32232-0019

FWS Log Number: 41910-2008-F-0300

Dear Colonel Grosskruger:

This document is the Service's review of the Mid Reach nourishment project and it's effects on the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*) and the Kemp's ridley (*Lepidochelys kempii*) sea turtles in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.).

The following will replace the sea turtle "Reasonable and Prudent Measures" and "Terms and Condition" in the Biological Opinion dated February 1, 2006. All other parts of the Biological Opinion will remain the same.

REASONABLE AND PRUDENT MEASURES

The Service has determined that the following reasonable and prudent measures are necessary and appropriate to minimize take of the loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles in the proposed beach nourishment or dredged channel material placement action area.

1. Beach quality sand suitable for sea turtle nesting, successful incubation, and hatchling emergence must be used for beach nourishment and dredged channel material placement.

2. The nourishment project must not occur from May 1 through October 31, the period of the main sea turtle egg laying and egg hatching season, to reduce the possibility of sea turtle nest burial, crushing of eggs, or nest excavation.

3. All derelict concrete, metal, coastal armoring geotextile material or other debris must

be removed from the beach prior to any sand placement.

4. If a dune system is already part of the project design, the placement and design of the dune must emulate the natural dune system to the maximum extent practicable, including the dune configuration and shape.

5. Daily early morning surveys for sea turtle nests must be conducted during the year the beach nourishment project is conducted and for at least two years following project completion.

6. A survey of all artificial lighting visible from the nourished beach must be completed. This information must be provided to the Service, FWC and the County or municipality.

7. A meeting between representatives of the contractor, the Service, the FWC, and the permitted sea turtle surveyor must be held prior to the commencement of work on this project.

8. Beach nourishment projects or dredged channel material placement conducted during the sea turtle nesting season but outside the peak period, must conduct surveys for early and late nesting sea turtles. Nests laid in the area of beach nourishment must be relocated to minimize sea turtle nest burial, crushing of eggs, or nest excavation.

9. Beach compaction must be monitored and tilling must be conducted immediately after completion of the beach nourishment project or dredged channel material placement and prior to the next three nesting seasons as needed to reduce the likelihood of impacting sea turtle nesting and hatching activities.

10. Escarpment formation must be monitored immediately after completion of the beach nourishment project or dredged channel material placement and prior to the next three nesting seasons to determine if escarpments are present and if present, must be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities.

11. Construction equipment and materials must be stored in a manner that will minimize impacts to nesting and hatching sea turtles during the early and late portions of the sea turtle nesting season to the maximum extent practicable.

12. Lighting associated with the project during the sea turtle nesting season must be minimized to reduce the possibility of disrupting and disorienting nesting and/or hatchling sea turtles.

13. A report describing the actions taken to implement the terms and conditions of this incidental take statement must be submitted to the Service by January 15 of the year following when the activity has occurred.

14. The Service or FWC must be notified if a sea turtle adult, hatchling, or egg, is harmed or destroyed as a direct or indirect result of the project.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Beach compatible fill must be placed on the beach or in any associated dune system. Beach compatible fill is material that maintains the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system. Such material must be predominately of carbonate, quartz or similar material with a particle size distribution ranging between 0.062mm (4.0Φ) and 4.76mm (-2.25Φ) (classified as sand by either the Unified Soils or the Wentworth classification), must be similar in color and grain size distribution (sand grain frequency, mean and median grain size and sorting coefficient) to the material in the historic beach sediment at the disposal site and must not contain:

   1a. Greater than 5 percent, by weight, silt, clay or colloids passing the #230 sieve (4.0φ);

   1b. Greater than 5 percent, by weight, fine gravel retained on the #4 sieve (- 2.25φ);

   1c. Coarse gravel, cobbles or material retained on the 3/4 inch sieve in a percentage or size greater than found on the native beach;

   1d. Construction debris, toxic material or other foreign matter; and

   1e. Material that will result in cementation of the beach.

   If rocks or other non-specified materials appear on the surface of the filled beach in excess of 50 percent of background in any 10,000 square foot area, then surface rock should be removed from those areas. These areas must also be tested for subsurface rock percentage and remediated as required. If the natural beach exceeds any of the limiting parameters listed above, then the fill material must not exceed the naturally occurring level for that parameter.

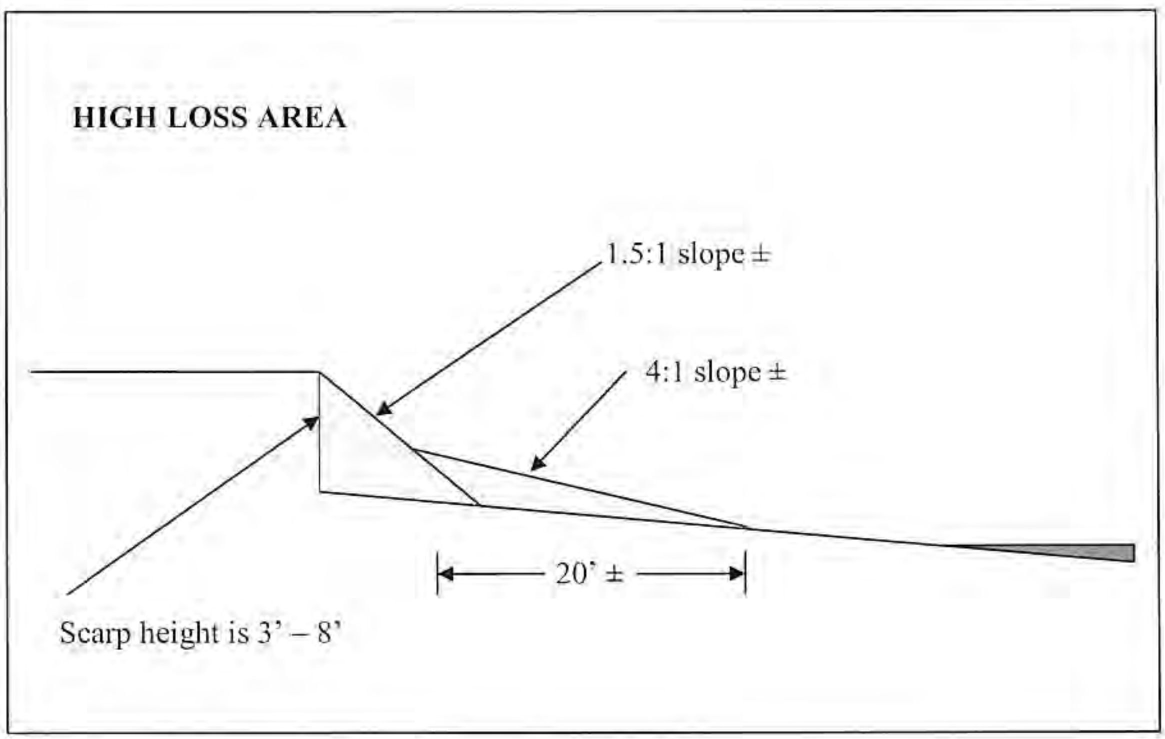
   Pursuant to subsection 62B-41.005(15), Florida Administrative Code (F.A.C.), sandy sediment derived from the maintenance of coastal navigation channels must be deemed suitable for beach placement with up to 10 percent fine material passing the #230 sieve, provided that it meets the criteria contained in 2b to 2e above and water quality standards. If this material contains between 10 percent and 20 percent fine material passing the #230 sieve by weight, and it meets all other sediment and water quality standards, it must be considered suitable for placement in the nearshore portion of the beach.

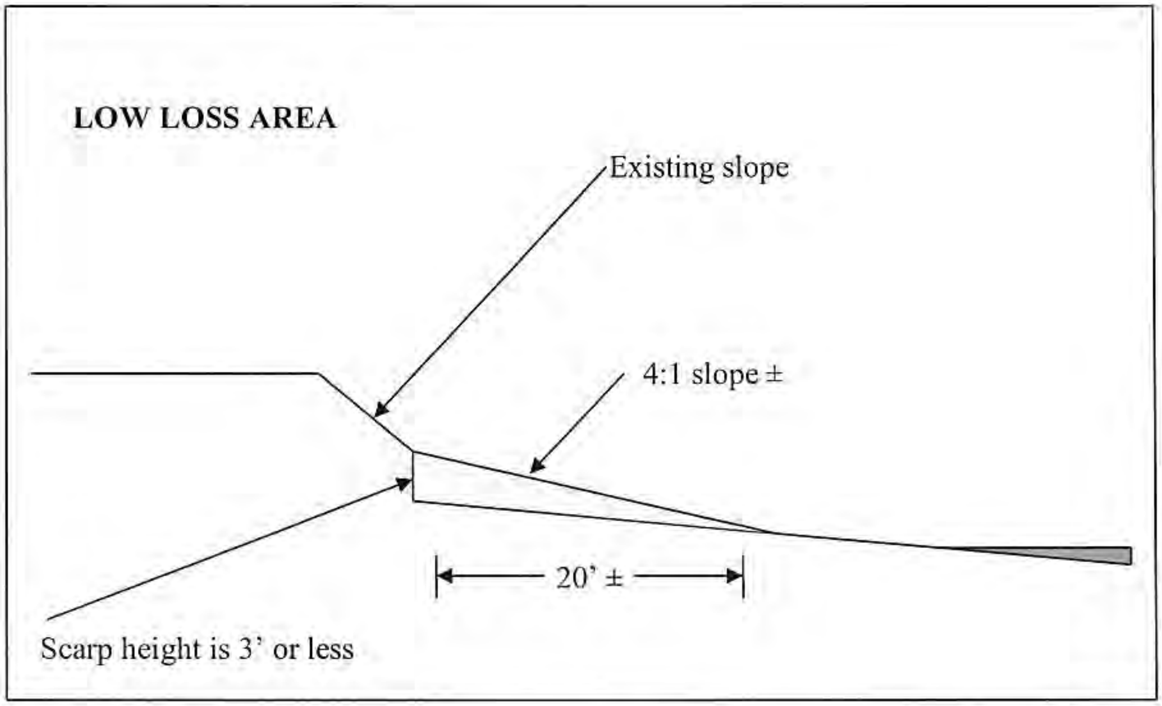
   These standards must not be exceeded in any 10,000 square foot section extending through the depth of the nourished beach. If the native beach exceeds any of the limiting parameters listed above, then the fill material must not exceed the naturally occurring level for that parameter.

2. Nourishment projects must be started after October 31 and be completed before May 1. During the May 1 through October 31 period, no construction equipment or pipes may be placed and/or stored on the beach.

3. All derelict concrete, metal, and coastal armoring geotextile material and other debris must be removed from the beach prior to any sand placement to the maximum extent practicable. Debris removal activities must be conducted during daylight hours only from March 1 through November 30 must not commence until completion of the sea turtle survey each day.

4. Dune restoration or creation included in the profile design (or project) must have a slope of 1.5:1 followed by a gradual slope of 4:1 for approximately 20 feet seaward on high erosion beach (Figure #) or a 4:1 slope (Figure #.) on a low erosion beach. If another slope is used, the Corps must either provide information that the new slope is similar to the preexisting project slope or provide nesting success data (ratio of false crawls to nests) for the sea turtle nesting season following the project completion. This will assist in determining if that slope was feasible for sea turtle nesting success in that area. If it is determined that nesting success was low due to the slope, the Corps will meet with the Service to discuss a new slope for the next nourishment event.





5. Beach nourishment project must report on all sea turtle nesting activity for the initial nesting season and for a minimum of two additional nesting seasons. Monitoring of nesting activity in the seasons following construction shall include daily surveys and any additional measures authorized by the Service and FWC.

6. Artificial beachfront lighting in the beach nourishment project must be managed by the applicant or local sponsor. For areas where there is no lighting ordinance in place the applicant or local sponsor must complete a survey of all lighting visible from the beach before and after the nourishment project using standard techniques for such a survey (attachment 1). For areas where there is lighting ordinance in place the applicant or local sponsor must complete a survey of all lighting visible from the beach only after the nourishment project using standard techniques for such a survey.

   The surveys shall document all lighting visible from the un- or previously nourished beach and then the nourished beach by May 15 following the nourishment work and again by June 15, July 15, August 15, and September 15 of that nesting season. For each light source visible, it must be documented that the property owner(s) have been notified of the problem light with recommendations for correcting the light. Recommendations must be in accordance with the county's or municipalities' specific lighting ordinance. For counties or municipalities with no lighting ordinance, recommendations must be in accordance with the Florida Model Lighting Ordinance for Marine Turtle Protection FAC 62B55. A summary report of each survey including documentation of property owner notification must be submitted to the Service (Table #) by the 1st of the following month; and a final summary report provided by December 15 of that year. After the final report is completed, a meeting must be set up with the local sponsor or applicant, county or municipality, FWC and the Service to discuss the survey report and documented sea turtle disorientations.

7. A meeting between representatives of the contractor, the Service, the FWC, and the permitted sea turtle surveyor must be held prior to the commencement of work on this project. At least 10-business days advance notice must be provided prior to conducting this meeting. The meeting will provide an opportunity for explanation and/or clarification of the sea turtle protection measures as well as additional guidelines when construction occurs during the nesting season such as storing equipment, minimizing driving, feral cats observation and reporting within the work area as well as follow up meetings during construction.

8. Beach nourishment projects or dredged channel material placement that occur during the period from March 1 through April 30, must conduct daily early morning surveys for sea turtle nests from March 1 through April 30 or until completion of the project (whichever is earliest). Beach nourishment project or dredged channel material placement occurring during the period from November 1 through November 30, must conduct daily early morning sea turtle nesting surveys 65 days prior to project initiation and continue through September 30. From March 1 through April 30 and November 1 through November 30, eggs must be relocated per the following requirements.

   8a. Nesting surveys and egg relocations will only be conducted by persons with prior experience and training in these activities and who is duly authorized to conduct such activities through a valid permit issued by FWC, pursuant to F.A.C 68E-1. Please contact FWC's Marine Turtle Management Program in Tequesta at (561) 575-5408 for information on the permit holder in the project area. Nesting surveys must be conducted daily between sunrise and 9 a.m. (this is for all time zones). The contractor must not initiate work until daily notice has been received from the sea turtle permit holder that the morning survey has been completed. Surveys must be performed in such a manner so as to ensure that construction activity does not occur in any location prior to completion of the necessary sea turtle protection measures.

   8b. Only those sea turtle nests that may be affected by sand placement activities will be relocated. Nests requiring relocation must be moved no later than 9 a.m. the morning following deposition to a nearby self-release beach site in a secure setting where artificial lighting will not interfere with hatchling orientation. Relocated nests must not be placed in organized groupings; relocated nests must be randomly staggered along the length and width of the beach in settings that are not expected to experience daily inundation by high tides or known to routinely experience severe erosion and egg loss, or subject to artificial lighting. Nest relocations in association with construction activities must cease when construction activities no longer threaten nests.

   8c. Sea turtle nests deposited within areas where construction activities have ceased, will not occur for 65 days, or nests in the nourished berm prior to tilling must be marked and left in situ unless other factors threaten the success of the nest. The turtle permit holder must install an on-beach marker at the nest site and/or a secondary marker at a point landward as possible to assure that future location of the nest will be possible should the on-beach marker be lost. No activity will occur within this area nor will any activities occur which could result in impacts to the nest. Nest sites must be inspected daily to assure nest markers remain in place and the nest has not been disturbed by the project activity.

9. Sand compaction must be monitored in the area of nourishment or dredged channel material placement immediately after completion and prior to March 1 for three (3) subsequent years in accordance with a protocol agreed to by the Service, FWC, and the applicant or local sponsor. At a minimum, the protocol provided under 9a and 9b below must be followed. If tilling is needed, the area must be tilled to a depth of 36 inches. Each pass of the tilling equipment must be overlapped to allow more thorough and even tilling. All tilling activity must be completed at least once from November 1 to April 15. A report on the results of the compaction monitoring must be submitted to the Service's field office prior to any tilling actions being taken. (NOTE: The requirement for compaction monitoring can be eliminated if the decision is made to till regardless of post-construction compaction levels. Additionally, out-year compaction monitoring and remediation are not required if placed material no longer remains on the dry beach.)

9a. Compaction sampling stations must be located at 500-foot intervals along the project area. One station must be at the seaward edge of the dune/bulkhead line (when material is placed in this area), and one station must be midway between the dune line and the high water line (normal wrack line).

9b. At each station, the cone penetrometer must be pushed to a depth of 6, 12, and 18 inches three times (three replicates). Material may be removed from the hole if necessary to ensure accurate readings of successive levels of sediment. The penetrometer may need to be reset between pushes, especially if sediment layering exists. Layers of highly compact material may lie over less compact layers. Replicates must be located as close to each other as possible, without interacting with the previous hole and/or disturbed sediments. The three replicate compaction values for each depth must be averaged to produce final values for each depth at each station. Reports will include all 18 values for each transect line, and the final 6 averaged compaction values.

9c. If the average value for any depth exceeds 500 pounds per square inch (psi) for any two or more adjacent stations, then that area must be tilled immediately prior to the following dates listed above.

9d. If values exceeding 500 psi are distributed throughout the project area but in no case do those values exist at two adjacent stations at the same depth, then consultation with the Service will be required to determine if tilling is required. If a few values exceeding 500 psi are present randomly within the project area, tilling will not be required.

9e. Tilling must occur landward of the wrack line and avoid all vegetated areas three (3) square feet or greater with a three (3) square foot buffer around the vegetated areas.

10. Visual surveys for escarpments along the project area must be made immediately after completion of the beach nourishment project or dredged channel material placement and during 30 days prior to March 1 for 3 subsequent years if sand still remains on the beach. Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet must be leveled and the beach profile must be reconfigured to minimize scarp formation by March 1. Any escarpment removal must be reported by location. If the project is completed during the early part of the sea turtle nesting and hatching season (March 1 through April 30), escarpments may be required to be leveled immediately, while protecting nests that have been relocated or left in place. Surveys for escarpments must be conducted weekly during the two nesting season following completion of the project. Surveys must include the number and location of escarpments, notations of the height of these escarpments shall be included (0 to 2 feet, 2 to 4 feet, and 4 feet or higher) as well as the maximum height of all escarpments. The Service must be contacted immediately if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service or FWC will provide a brief written authorization that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken must be submitted to the Service's Field Office (Table #). (NOTE: Out-year escarpment monitoring and remediation are not required if placed material no longer remains on the dry beach).

11. Staging areas for construction equipment must be located off the beach from March 1 through April 30 and November 1 through November 30, if these areas are available. Nighttime storage of construction equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. In addition, all construction pipes that are placed on the beach must be located as far landward as possible without compromising the integrity of the existing or reconstructed dune system. Temporary storage of pipes must be off the beach to the maximum extent possible. If the pipes must be on the beach it must be in such a manner to minimize the impact to nesting habitat and must not compromise the integrity of the dune systems. Pipes placed parallel to the dune must be five to ten feet away from the toe of the dune.

12. Direct lighting of the beach and nearshore waters must be limited to the immediate construction area from March 1 through April 30 and November 1 through November 30, and must comply with safety requirements. Lighting on offshore or onshore equipment must be minimized through reduction, shielding, lowering, and appropriate placement to avoid excessive illumination of the waters surface and nesting beach while meeting all Coast Guard, EM 385-1-1, and OSHA requirements. Light intensity of lighting plants must be reduced to the minimum standard required by OSHA for General Construction areas, in order not to misdirect sea turtles. Shields must be affixed to the light housing and be large enough to block light from all lamps from being transmitted outside the construction area (see Figure 10).

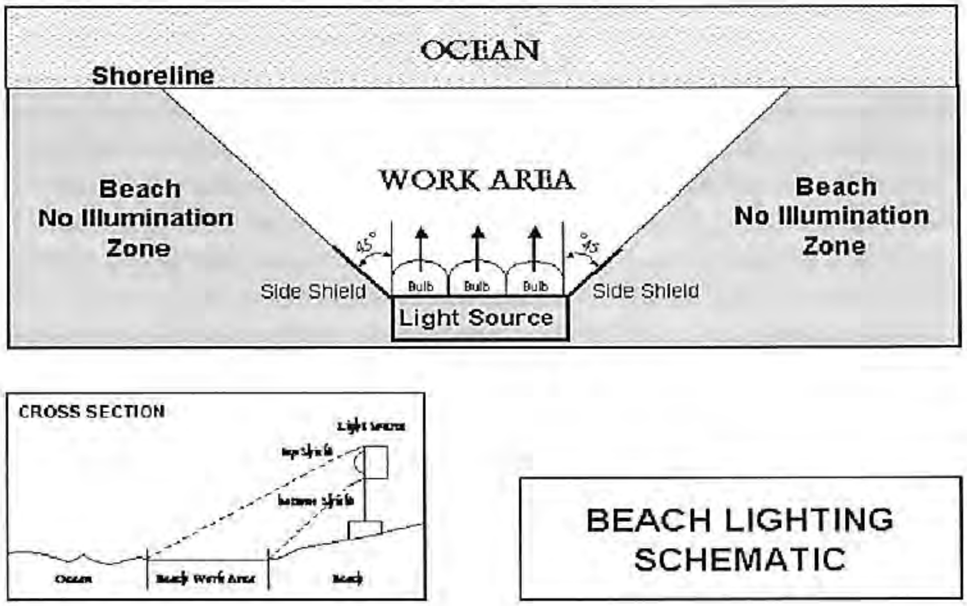


Figure #10. Beach lighting schematic.

Reporting

1. A report describing the projects conducted during the year and actions taken to implement the reasonable and prudent measures and terms and conditions of this incidental take statement shall be submitted to the Service (Table #) by March 1 of the following year of completing the proposed work for each year when the activity has occurred. This report will include the following information:

All projects	Project location (include DEP R-Monuments)
	Project description
	Dates of actual construction activities
	Names and qualifications of personnel involved in sea turtle nest surveys and relocation activities (separate the nests surveys for nourished and non-nourished areas)
	Descriptions and locations of self-release beach sites
	Nest survey and relocation results and the information outlined in Table #

2. In the event a sea turtle nest is excavated during construction activities, the permitted person responsible for egg relocation for the project must be notified so the eggs can be moved to a suitable relocation site.

3. Upon locating or injured sea turtle adult, hatchling, or egg, beach mouse may have been harmed or destroyed as a direct or indirect result of the project, the Corps, permittee, and/or local sponsor must be responsible for notifying FWC Wildlife Alert at 1-888-404-FWCC (3922) and the Service's North Florida Field Office:

Care must be taken in handling injured turtles or eggs, beach mice or piping plovers to ensure effective treatment or disposition, and in handling dead specimens to preserve biological materials in the best possible state for later analysis.

Table 1: Sea Turtle Monitoring for Beach Nourishment or Dredged Material Placement

CHARACTERISTIC	PARAMETER	MEASUREMENT	VARIABLE
Nesting Success	False crawls - number	Visual assessment of all false crawls	Number and location of false crawls in nourished areas and non nourished areas: any interaction of the turtle with obstructions, such as groins, seawalls, or scarps, should be noted.
	False crawl - type	Categorization of the stage at which nesting was abandoned	Number in each of the following categories: emergence-no digging, preliminary body pit, abandoned egg chamber.
	Nests	Number	The number of sea turtle nests in nourished and non nourished areas should be noted. If possible, the location of all sea turtle nests must be marked on map of project, and approximate distance to sea walls or scarps measured using a meter tape. Any abnormal cavity morphologies should be reported as well as whether turtle touched groins, seawalls, or scarps during nest excavation
		Lost Nests	The number of nests lost to inundation, erosion or the number with lost markers that could not be found.
	Lighting Impacts	Disoriented sea turtles	The number of disoriented hatchlings and adults must be documented and reported in accordance with existing FWC protocol for disorientation events.
Reproductive Success	Emergence & hatching success	Standard survey protocol	Numbers of the following: unhatched eggs, depredated nests and eggs, live pipped eggs, dead pipped eggs, live hatchlings in nest, dead hatchlings in nest, hatchlings emerged, disoriented hatchlings, depredated hatchlings

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that no more than 7.78 miles of nesting loggerhead, green, leatherback, Kemp's ridley, and hawksbill sea turtles will be incidentally taken. If during the course of the action, this level is exceeded; such incidental take represents new information requiring initiation of consultation and review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking and review with the service the need for possible modification of the reasonable and prudent measures.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
6620 Southpoint Drive, South
Suite 310
Jacksonville, Florida 32216-0912

IN REPLY REFER TO:

41910-2006-F-0048

February 1, 2006

Surname

Colonel Robert M. Carpenter
U.S. Army Corps of Engineers
701 San Marcos Boulevard, Room 372,
Jacksonville, Florida 32207-8175

RE: FWS Log No: 41910-2006-F-0048

Dear Colonel Carpenter:

This document transmits the Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed beach nourishment project located in Brevard County, Florida, and its effects on loggerheads, greens, leatherbacks, and hawksbill sea turtles in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). Your November 16, 2005 request for formal consultation was received on November 16, 2005.

This biological opinion is for sand placement along Brevard Mid Reach area. Information is provided in the October 13, 2005 coordination letter, the public notice, Brevard County, Florida Mid Reach Shore Protection Project Revision A (11/10/05), Post-construction Monitoring of the Canaveral Shoals II Offshore Borrow Area, the December 6, 2005 meeting, telephone conversations of October 11, 2005 with Irene Sadowski, and other sources of information. A complete administrative record of this consultation is on file at Jacksonville Field Office.

CONSULTATION HISTORY

The Mid Reach shoreline was deleted from the originally proposed federal project limits in 1996 because of environmental concerns related to the burial of the existing nearshore rock outcrops by conventional beach nourishment. The Service determined that in order to further consider beach nourishment alternatives along the Mid-Reach, it would be necessary to (1) more definitively map the rock resource, (2) demonstrate the severity of the beach erosion problem relative to the local abundance of the rock, (3) evaluate alternative solutions and their potential environmental impacts, and (4) present a specific plan or proposal for comment.

On October 11, 2005, the Service received a call from Irene Sadowski of the Corps with information on the Mid Reach shore protection project. On October 13, 2005, the Corps initiated formal Section 7 consultation with the Service for the beach nourishment and shoreline stabilization project for Brevard Mid Reach area. On December 6, a meeting was held with representatives of the Corps, the Florida Department of Protection (DEP), NOAA Fisheries, Florida Fish and Wildlife Conservation Commission, Olsen and Associates, Dynamac, and the Service. The Corps determined that this project may affect the loggerhead, green, leatherback, and hawksbill sea turtles. In addition, the Corps made a determination that the project may affect but was not likely to adversely affect the West Indian manatee (*Trichechus manatus*), the southeastern beach mouse (*Peromyscus polionotus nineiventris*) and the piping plover (*Charadrius milodus*). The Service concurred with these determinations.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Brevard County is located on Florida's central Atlantic coast and includes about 72 miles of sandy, ocean shoreline. Of this, 32 miles are mostly undeveloped federal coastline north of Canaveral Harbor Entrance. The other forty miles feature a diverse mix of public, private, and federal oceanfront development. The present study principally focuses upon 7.6- miles of this developed shoreline, from the south end of Patrick AFB to just north of Indialantic (R75.3 – R118.3); or, between approximately 13.6 and 21.2 statute miles south of Canaveral Harbor Entrance, by shorefront measure. This 7.6-mile area is referred to as the "Mid-Reach". There have been no prior, significant beach nourishment projects constructed along the Mid-Reach shoreline. Small-scale, truck-haul placement of sand against the eroded bluffline has been conducted by property owners at many locations after storm events. Brevard County Board of County Commissioners (BCBOCC) is proposing to place approximately 1,800,000 cubic yards of beach-compatible sand from the previously borrowed Canaveral Shoals Borrow Area I and II. The borrow site is located approximately 3.5 miles east off Brevard County shoreline. Sand will be placed by truck-haul along R-Monument 75.4 to R-Monument 99. This sand will initially be stockpiled above the mean high water line (MHWL) south of R-Monument 99. The remaining project area (R-Monument 99 to R-Monument 118.7) will be nourished by hydraulic methods.

The project also consists of using a nearshore sand rehandling area located between 2600 feet and 5050 feet seaward between R-Monument 107 and R-Monument 111. The rehandling area will require placement of a minimum of a two-foot thick layer if beach-compatible sand above the ambient seabed. Beach compatible sand placed on this layer will subsequently be transferred to the beach placement area by hydraulic dredge. The proposed project will place approximately 1,800,000 cubic yards of fill material along the Mid Reach of 7.6 miles of linear beach (R75.4 to R-118.3).

The sand source for both projects will be the Canaveral Shoals II offshore borrow areas. The fill material will be similar in both coloration and grain size distribution to the native beach. The fill material will be free of construction debris, rocks, or other foreign matter and will not contain, on average, greater than 10 percent fines (i.e., silt and clay) (passing the #200 sieve) and will not contain, on average, greater than 5 percent coarse gravel or cobbles, exclusive of shell material (retained by the #4 sieve). The sand will be dredged and trucked to the nourishment site. The Corps has committed not to do the work during the sea turtle nesting season, May 1 through November 30.

STATUS OF THE SPECIES/CRITICAL HABITAT

Species/critical habitat description

Loggerhead Sea Turtle

The loggerhead sea turtle (*Caretta caretta*), listed as a threatened species on July 28, 1978 (43 FR 32800), inhabits the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans. Loggerhead sea turtles nest within the continental U.S. from Louisiana to Virginia. Major nesting concentrations in the U.S. are found on the coastal islands of North Carolina, South Carolina, and Georgia, and on the Atlantic and Gulf coasts of Florida (Hopkins and Richardson 1984).

No critical habitat has been designated for the loggerhead sea turtle.

Green Sea Turtle

The green sea turtle (*Chelonia mydas*) was federally listed as a protected species on July 28, 1978 (43 FR 32800). Breeding populations of the green turtle in Florida and along the Pacific Coast of Mexico are listed as endangered; all other populations are listed as threatened. The green turtle has a worldwide distribution in tropical and subtropical waters. Major green turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica, and Surinam. Within the U.S., green turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and in larger numbers along the east coast of Florida, particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991a). Nesting also has been documented along the Gulf coast of Florida on Santa Rosa Island (Okaloosa and Escambia Counties) and from Pinellas County through Collier County (Florida Fish and Wildlife Conservation Commission, unpublished data). Green turtles have been known to nest in Georgia, but only on rare occasions (Georgia Department of Natural Resources, unpublished data). The green turtle also nests sporadically in North Carolina and South Carolina (North Carolina Wildlife Resources Commission, unpublished data; South Carolina Department of Natural Resources, unpublished data). Unconfirmed nesting of green turtles in Alabama has also been reported (Bon Secour National Wildlife Refuge, unpublished data).

Critical habitat for the green sea turtle has been designated for the waters surrounding Culebra Island, Puerto Rico, and its outlying keys.

Leatherback Sea Turtle

The leatherback sea turtle (*Dermochelys coriacea*), listed as an endangered species on June 2, 1970 (35 FR 8491), nests on shores of the Atlantic, Pacific and Indian Oceans. Non-breeding animals have been recorded as far north as the British Isles and the Maritime Provinces of Canada and as far south as Argentina and the Cape of Good Hope (Pritchard 1992). Nesting grounds are distributed worldwide, with the Pacific Coast of Mexico supporting the world's largest known concentration of nesting leatherbacks. The largest nesting colony in the wider Caribbean region is found in French Guiana, but nesting occurs frequently, although in lesser numbers, from Costa Rica to Columbia and in Guyana, Surinam, and Trinidad (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992, National Research Council 1990a).

The leatherback regularly nests in the U.S. in Puerto Rico, the U.S. Virgin Islands, and along the Atlantic coast of Florida as far north as Georgia (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992). Leatherback turtles have been known to nest in Georgia, South Carolina, and North Carolina, but only on rare occasions (Murphy 1996, Winn 1996, Boettcher 1998). Leatherback nesting also has been reported on the northwest coast of Florida (LeBuff 1990; Florida Fish and Wildlife Conservation Commission, unpublished data); a false crawl (non-nesting emergence) has been observed on Sanibel Island (LeBuff 1990).

Marine and terrestrial critical habitat for the leatherback sea turtle has been designated at Sandy Point on the western end of the island of St. Croix, U.S. Virgin Islands.

Hawksbill Sea Turtle

The hawksbill sea turtle (*Eretmochelys imbricata*) was listed as an endangered species on June 2, 1970 (35 FR 8491). The hawksbill is found in tropical and subtropical seas of the Atlantic, Pacific, and Indian Oceans. The species is widely distributed in the Caribbean Sea and western Atlantic Ocean. Within the continental U.S., hawksbill sea turtle nesting is rare and is restricted to the southeastern coast of Florida (Volusia through Dade Counties) and the Florida Keys (Monroe County) (Meylan 1992, Meylan *et al.* 1995). However, hawksbill tracks are difficult to differentiate from those of loggerheads and may not be recognized by surveyors. Therefore, surveys in Florida likely underestimate actual hawksbill nesting numbers (Meylan *et al.* 1995). In the U.S. Caribbean, hawksbill nesting occurs on beaches throughout Puerto Rico and the U.S. Virgin Islands (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1993).

Critical habitat for the hawksbill sea turtle has been designated for selected beaches and/or waters of Mona, Monito, Culebrita, and Culebra Islands, Puerto Rico.

Table 1: Marine Turtle Nesting Activity along the Mid Reach (12.0km) in Brevard County, Florida (1989 -2000)

Loggerhead		**Green**		**Leatherback**	
Nests per km per year	False crawl ratio	Nests per km every 2 yrs	False crawl ratio	Total Nests (12-yrs)	False crawls (12-yrs)
240	0.86	10.7	0.88	2	0

Life history

Loggerhead Sea Turtle

Loggerheads are known to nest from one to seven times within a nesting season (Talbert *et al.* 1980, Richardson and Richardson 1982, Lenarz *et al.* 1981, among others); the mean is approximately 4.1 (Murphy and Hopkins 1984). The interval between nesting events within a season varies around a mean of about 14 days (Dodd 1988). Mean clutch size varies from about 100 to 126 along the southeastern United States coast (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991b). Nesting migration intervals of 2 to 3 years are most common in loggerheads, but the number can vary from 1 to 7 years (Dodd 1988). Age at sexual maturity is believed to be about 20 to 30 years (Turtle Expert Working Group 1998).

Green Sea Turtle

Green turtles deposit from one to nine clutches within a nesting season, but the overall average is about 3.3. The interval between nesting events within a season varies around a mean of about 13 days (Hirth 1997). Mean clutch size varies widely among populations. Average clutch size reported for Florida was 136 eggs in 130 clutches (Witherington and Ehrhart 1989). Only occasionally do females produce clutches in successive years. Usually 2, 3, 4, or more years intervene between breeding seasons (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991a). Age at sexual maturity is believed to be 20 to 50 years (Hirth 1997).

Leatherback Sea Turtle

Leatherbacks nest an average of five to seven times within a nesting season, with an observed maximum of 11 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992). The interval between nesting events within a season is about 9 to 10 days. Clutch size averages 101 eggs on Hutchinson Island, Florida (Martin 1992). Nesting migration intervals of 2 to 3 years were observed in leatherbacks nesting on the Sandy Point National Wildlife Refuge, St. Croix, U.S. Virgin Islands (McDonald and Dutton 1996). Leatherbacks are believed to reach sexual maturity in 6 to 10 years (Zug and Parham 1996).

Hawksbill Sea Turtle

Hawksbills nest on average about 4.5 times per season at intervals of approximately 14 days (Corliss *et al.* 1989). In Florida and the U.S. Caribbean, clutch size is approximately 140 eggs, although several records exist of over 200 eggs per nest (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1993). On the basis of limited information, nesting migration intervals of 2 to 3 years appear to predominate. Hawksbills are recruited into the reef environment at about 14 inches in length and are believed to begin breeding about 30 years later. However, the time required to reach 14 inches in length is unknown and growth rates vary geographically. As a result, actual age at sexual maturity is not known.

Population dynamics

Loggerhead Sea Turtle

Total estimated nesting in the Southeast is approximately 50,000 to 70,000 nests per year (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991b). In 1998, there were over 80,000 nests in Florida alone. From a global perspective, the southeastern U.S. nesting aggregation is of paramount importance to the survival of the species and is second in size only to that which nests on islands in the Arabian Sea off Oman (Ross 1982, Ehrhart 1989, National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991b). The status of the Oman colony has not been evaluated recently, but its location in a part of the world that is vulnerable to disruptive events (e.g., political upheavals, wars, catastrophic oil spills) is cause for considerable concern (Meylan *et al.* 1995). The loggerhead nesting aggregations in Oman, the southeastern U.S., and Australia account for about 88 percent of nesting worldwide (National Marine Fisheries Service and U.S. Fish and

Wildlife Service 1991b). About 80 percent of loggerhead nesting in the southeastern U.S. occurs in six Florida counties (Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991b).

Green Sea Turtle

About 200 to 1,100 females are estimated to nest on beaches in the continental U.S. In the U.S. Pacific, over 90 percent of nesting throughout the Hawaiian archipelago occurs at the French Frigate Shoals, where about 200 to 700 females nest each year. Elsewhere in the U.S. Pacific, nesting takes place at scattered locations in the Commonwealth of the Northern Marianas, Guam, and American Samoa. In the western Pacific, the largest green turtle nesting aggregation in the world occurs on Raine Island, Australia, where thousands of females nest nightly in an average nesting season. In the Indian Ocean, major nesting beaches occur in Oman where 6,000 to 20,000 females are reported to nest annually.

Leatherback Sea Turtle

Recent estimates of global nesting populations indicate 26,000 to 43,000 nesting females annually (Spotila *et al.* 1996). The largest nesting populations at present occur in the western Atlantic in French Guiana (4,500 to 7,500 females nesting/year) and Colombia (estimated several thousand nests annually), and in the western Pacific in West Papua (formerly Irian Jaya) and Indonesia (about 600 to 650 females nesting/year). In the United States, small nesting populations occur on the Florida east coast (35 females/year), Sandy Point, U.S. Virgin Islands (50 to 100 females/year), and Puerto Rico (30 to 90 females/year).

Hawksbill Sea Turtle

About 15,000 females are estimated to nest each year throughout the world with the Caribbean accounting for 20 to 30 percent of the world's hawksbill population. Only five regional populations remain with more than 1,000 females nesting annually (Seychelles, Mexico, Indonesia, and two in Australia). Mexico is now the most important region for hawksbills in the Caribbean with 3,000 to 4,500 nests/year. Other significant but smaller populations in the Caribbean still occur in Martinique, Jamaica, Guatemala, Nicaragua, Grenada, Dominican Republic, Turks and Caicos Islands, Cuba, Puerto Rico, and U.S. Virgin Islands. In the U.S. Caribbean, about 100 to 350 nests/year are laid on Mona Island, Puerto Rico, and 60 to 120 nests/year on Buck Island Reef National Monument, U.S. Virgin Islands. In the U.S. Pacific, hawksbills nest only on main island beaches in Hawaii, primarily along the east coast of the island of Hawaii. Hawksbill nesting has also been documented in American Samoa and Guam.

Status and distribution

Loggerhead Sea Turtle

Genetic research involving analysis of mitochondrial DNA has identified five different loggerhead subpopulations/nesting aggregations in the western North Atlantic: (1) the Northern Subpopulation occurring from North Carolina to around Cape Canaveral, Florida (about 29° N.); (2) South Florida Subpopulation occurring from about 29° N. on Florida's east coast to Sarasota on Florida's west coast; (3) Dry Tortugas, Florida, Subpopulation, (4) Northwest Florida Subpopulation occurring at Eglin Air Force Base and the beaches near Panama City; and (5) Yucatán Subpopulation occurring on the eastern Yucatán Peninsula, Mexico (Bowen 1994, 1995; Bowen *et al.* 1993; Encalada *et al.* 1998; Pearce 2001). These data indicate that gene flow between these five regions is very low. If nesting females are extirpated from one of these regions, regional dispersal will not be sufficient to replenish the depleted nesting subpopulation. The Northern Subpopulation has declined substantially since the early 1970s, but most of that decline occurred prior to 1979. No significant trend has been detected in recent years (Turtle Expert Working Group 1998, 2000). Adult loggerheads of the South Florida Subpopulation have shown significant increases over the last 25 years, indicating that the population is recovering, although a trend could not be detected from the State of Florida's Index Nesting Beach Survey program from 1989 to 1998. Nesting surveys in the Dry Tortugas, Northwest Florida, and Yucatán Subpopulations have been too irregular to date to allow for a meaningful trend analysis (Turtle Expert Working Group 1998, 2000).

Threats include incidental take from channel dredging and commercial trawling, longline, and gill net fisheries; loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and disease. There is particular concern about the extensive incidental take of juvenile loggerheads in the eastern Atlantic by longline fishing vessels from several countries.

Green Sea Turtle

Total population estimates for the green turtle are unavailable, and trends based on nesting data are difficult to assess because of large annual fluctuations in numbers of nesting females. For instance, in Florida, where the majority of green turtle nesting in the southeastern U.S. occurs, estimates range from 200 to 1,100 females nesting annually. Populations in Surinam, and Tortuguero, Costa Rica, may be stable, but there is insufficient data for other areas to confirm a trend.

A major factor contributing to the green turtle's decline worldwide is commercial harvest for eggs and food. Fibropapillomatosis, a disease of sea turtles characterized by the development of multiple tumors on the skin and internal organs, is also a mortality factor and has seriously impacted green turtle populations in Florida, Hawaii, and other parts of the world. The tumors interfere with swimming, eating, breathing, vision, and reproduction, and turtles with heavy tumor burdens may die. Other threats include loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and incidental take from channel dredging and commercial fishing operations.

Leatherback Sea Turtle

Declines in leatherback nesting have occurred over the last two decades along the Pacific coasts of Mexico and Costa Rica. The Mexican leatherback nesting population, once considered to be the world's largest leatherback nesting population (65 percent of worldwide population), is now less than one percent of its estimated size in 1980. Spotila *et al.* (1996) recently estimated the number of leatherback sea turtles nesting on 28 beaches throughout the world from the literature and from communications with investigators studying those beaches. The estimated worldwide population of leatherbacks in 1995 was about 34,500 females on these beaches with a lower limit of about 26,200 and an upper limit of about 42,900. This is less than one third the 1980 estimate of 115,000. Leatherbacks are rare in the Indian Ocean and in very low numbers in the western Pacific Ocean.

The largest population is in the western Atlantic. Using an age-based demographic model, Spotila *et al.* (1996) determined that leatherback populations in the Indian Ocean and western Pacific Ocean cannot withstand even moderate levels of adult mortality and that even the Atlantic populations are being exploited at a rate that cannot be sustained. They concluded that leatherbacks are on the road to extinction and further population declines can be expected unless we take action to reduce adult mortality and increase survival of eggs and hatchlings.

The crash of the Pacific leatherback population is believed primarily to be the result of exploitation by humans for the eggs and meat, as well as incidental take in numerous commercial fisheries of the Pacific. Other factors threatening leatherbacks globally include loss or degradation of nesting habitat from coastal development; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; and watercraft strikes.

Hawksbill Sea Turtle

The hawksbill sea turtle has experienced global population declines of 80 percent or more during the past century and continued declines is projected (Meylan and Donnelly 1999). Most populations are declining, depleted, or remnants of larger aggregations. Hawksbills were previously abundant, as evidenced by high-density nesting at a few remaining sites and by trade statistics. The decline of this species is primarily due to human exploitation for tortoiseshell. While the legal hawksbill shell trade ended when Japan agreed to stop importing shell in 1993, a significant illegal trade continues. It is believed that individual hawksbill populations around the world will continue to disappear under the current regime of exploitation for eggs, meat, and tortoiseshell, loss of nesting and foraging habitat, incidental capture in fishing gear, ingestion of and entanglement in marine debris, oil pollution, and boat collisions. Hawksbills are closely associated with coral reefs, one of the most endangered of all marine ecosystem types.

Analysis of the species/critical habitat likely to be affected

The proposed action has the potential to adversely affect nesting females, nests, and hatchlings within the proposed project area. The effects of the proposed action on sea turtles will be considered further in the remaining sections of this biological opinion. Potential effects include destruction of nests deposited within the boundaries of the proposed project, harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities, disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting, behavior modification of nesting females due to escarpment formation within the project area during a nesting season resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs. The quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest.

Critical habitat has not been designated in the continental United States; therefore, the proposed action would not result in an adverse modification.

ENVIRONMENTAL BASELINE

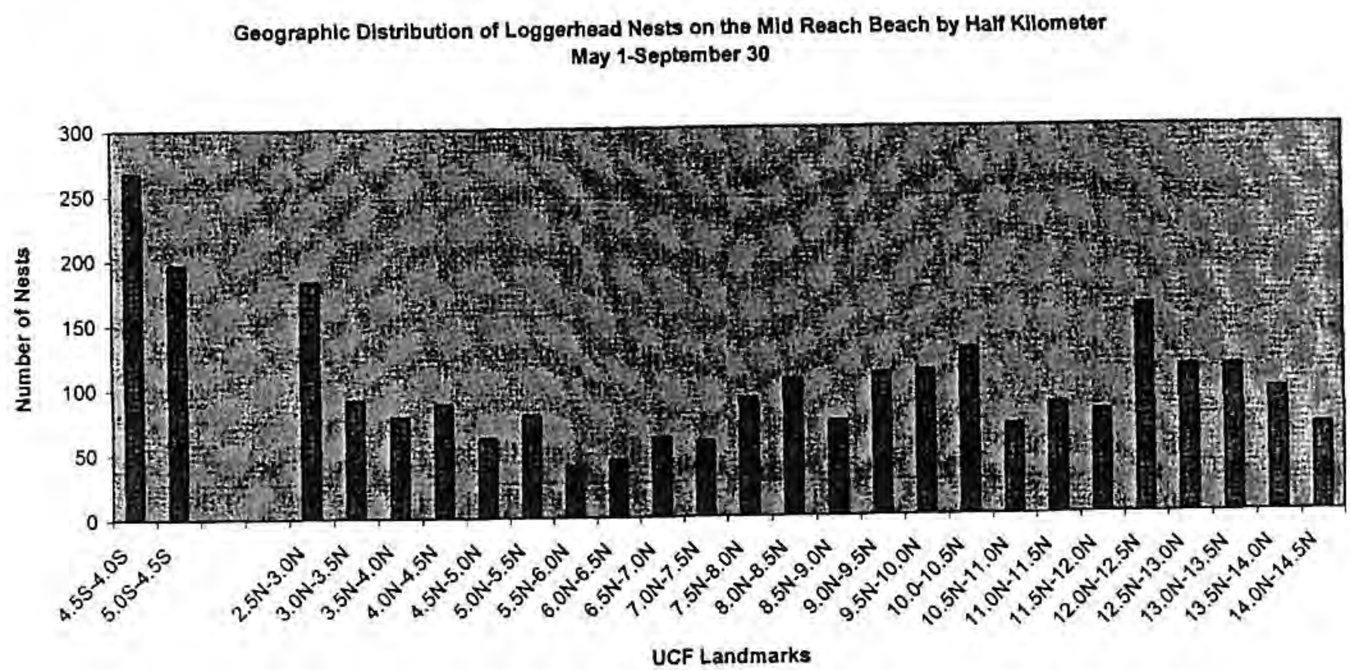
Status of the species within the action area

Loggerhead Sea Turtle

The loggerhead sea turtle nesting and hatching season for Southern Florida Atlantic beaches extends from March 15 through November 30. Incubation ranges from about 45 to 95 days.

The Brevard Mid Reach project area has a significant number of loggerhead nests. For the current nesting season (2004-2005) through September 30, 2005, there were 2,643 loggerhead turtle nests within the 13 km mid reach area.

The following graph is from the "Brevard County-Mid-Reach Main Season Monitoring."



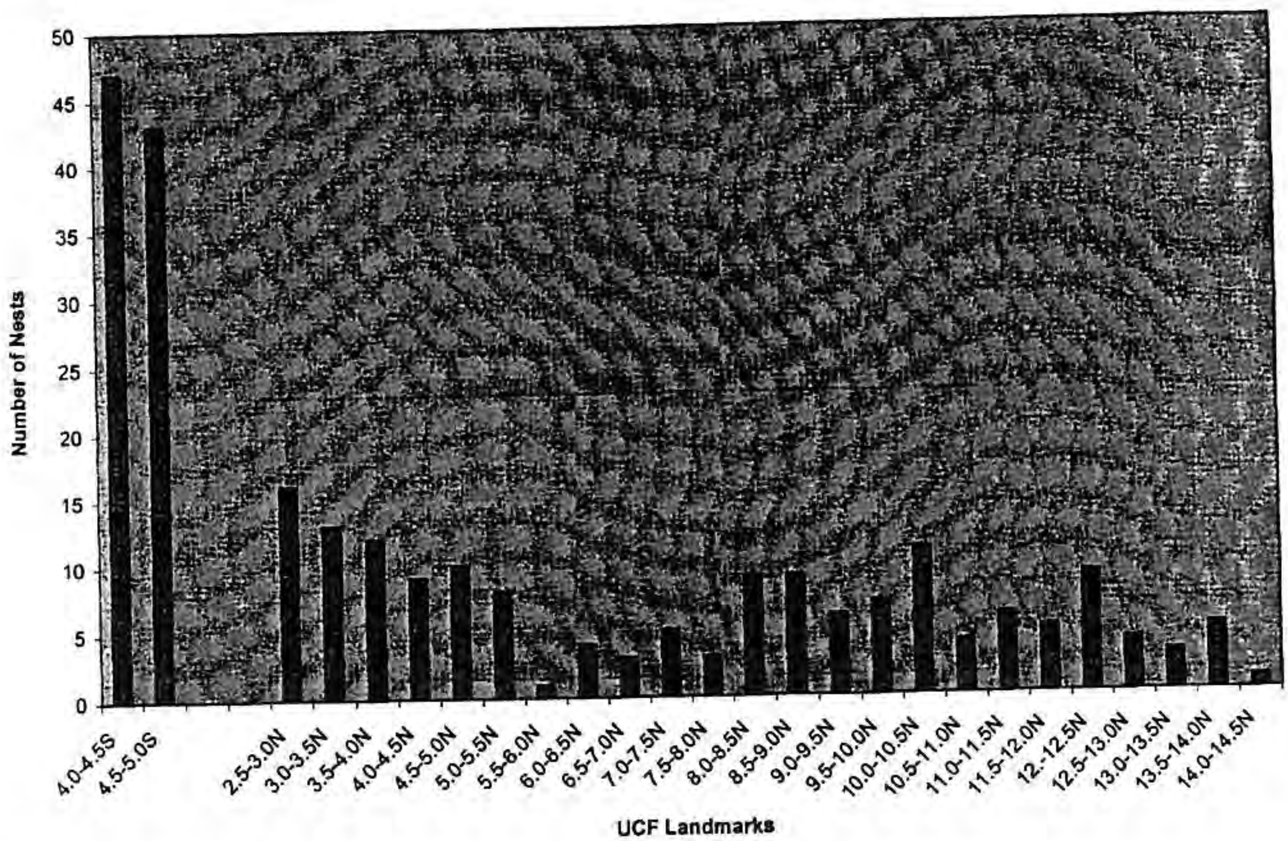
Green Sea Turtle

The green sea turtle nesting and hatching season for Southern Florida Atlantic extends from May 1 through November 30. Incubation ranges from about 45 to 75 days.

The Brevard Mid Reach project area has a significant number of green turtle nests. For the current nesting season (2004-2005) through September 30, 2005, there were 253 green turtle nests.

The following graph is from "Brevard County-Mid-Reach Main Season Monitoring."

Geographic Distribution of Green Turtle Nests on the Mid Reach Beach by Half Kilometer
May 1-September 30



Leatherback Sea Turtle

The leatherback sea turtle nesting and hatching season for Southern Florida Atlantic beaches extends from February 15 through November 15. Incubation ranges from about 55 to 75 days.

The Brevard Mid Reach project area has had a few leatherback nests over the years. However, for the current nesting season (2004-2005) through September 30, 2005, there were no leatherback nests.

Hawksbill Sea Turtle

The hawksbill sea turtle nesting and hatching season for Southern Florida Atlantic beaches extends from June 1 through December 31. Incubation lasts about 60 days.

Hawksbill sea turtle nesting is rare and is restricted to the southeastern coast of Florida (Volusia through Dade Counties) and the Florida Keys (Monroe County) (Meylan 1992, Meylan *et al.* 1995). However, hawksbill tracks are difficult to differentiate from those of loggerheads and may not be recognized by surveyors. Therefore, surveys in Florida likely underestimate actual hawksbill nesting numbers (Meylan *et al.* 1995). In the U.S. Caribbean, hawksbill nesting occurs on beaches throughout Puerto Rico and the U.S. Virgin Islands (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1993).

Factors affecting the species environment within the action area

EFFECTS OF THE ACTION

Factors to be considered

Placement of sand on an eroded section of beach or an existing beach in and of itself may not provide suitable nesting habitat for sea turtles. Although beach nourishment may increase the potential nesting area, significant negative impacts to sea turtles may result if protective measures are not incorporated during construction. Nourishment during the nesting season, particularly on or near high density nesting beaches, can cause increased loss of offspring from human-caused mortality and, along with other mortality sources, may significantly impact the long-term survival of the species. For instance, projects conducted during the nesting and hatching season could result in the loss of sea turtles through disruption of adult nesting activity and by burial or crushing of nests or hatchlings. While a nest monitoring and egg relocation program would reduce these impacts, nests may be inadvertently missed or misidentified as false crawls during daily patrols. In addition, nests may be destroyed by operations at night prior to beach patrols being performed. Even under the best of conditions, about 7 percent of the nests can be missed by experienced sea turtle surveyors (Schroeder 1994).

Analyses for effects of the action

Beneficial Effects

The placement of sand on a beach with reduced dry fore-dune habitat may increase sea turtle nesting habitat if the placed sand is highly compatible (i.e., grain size, shape, color, etc.) with naturally occurring beach sediments in the area, and compaction and escarpment remediation measures are incorporated into the project. In addition, a nourished beach that is designed and constructed to mimic a natural beach system may be more stable than the eroding one it replaces, thereby benefiting sea turtles.

Direct Effects

Placement of sand on a beach in and of itself may not provide suitable nesting habitat for sea turtles. Although beach nourishment may increase the potential nesting area, significant negative impacts to sea turtles may result if protective measures are not incorporated during project construction. Nourishment during the nesting season, particularly on or near high density nesting beaches, can cause increased loss of eggs and hatchlings and, along with other mortality sources, may significantly impact the long-term survival of the species. For instance, projects conducted during the nesting and hatching season could result in the loss of sea turtles through disruption of adult nesting activity and by burial or crushing of nests or hatchlings. While a nest monitoring and egg relocation program would reduce these impacts, nests may be inadvertently missed (when crawls are obscured by rainfall, wind, and/or tides) or misidentified as false crawls during daily patrols. In addition, nests may be destroyed by operations at night prior to beach patrols being performed.

Even under the best of conditions, about 7 percent of the nests can be misidentified as false crawls by experienced sea turtle nest surveyors (Schroeder 1994).

1. Nest relocation

Besides the potential for missing nests during a nest relocation program, there is a potential for eggs to be damaged by their movement, particularly if eggs are not relocated within 12 hours of deposition (Limpus *et al.* 1979). Nest relocation can have adverse impacts on incubation temperature (and hence sex ratios), gas exchange parameters, hydric environment of nests, hatching success, and hatchling emergence (Limpus *et al.* 1979, Ackerman 1980, Parmenter 1980, Spotila *et al.* 1983, McGehee 1990). Relocating nests into sands deficient in oxygen or moisture can result in mortality, morbidity, and reduced behavioral competence of hatchlings. Water availability is known to influence the incubation environment of the embryos and hatchlings of turtles with flexible-shelled eggs, which has been shown to affect nitrogen excretion (Packard *et al.* 1984), mobilization of calcium (Packard and Packard 1986), mobilization of yolk nutrients (Packard *et al.* 1985), hatchling size (Packard *et al.* 1981, McGehee 1990), energy reserves in the yolk at hatching (Packard *et al.* 1988), and locomotory ability of hatchlings (Miller *et al.* 1987).

Comparisons of hatching success between relocated and *in situ* nests have noted significant variation ranging from a 21 percent decrease to a 9 percent increase for relocated nests (Florida Fish and Wildlife Conservation Commission, unpublished data). Comparisons of emergence success between relocated and *in situ* nests have also noted significant variation ranging from a 23 percent decrease to a 5 percent increase for relocated nests (Florida Fish and Wildlife Conservation Commission, unpublished data). A 1994 study of hatching and emergence success of *in situ* and relocated nests at seven sites in Florida found that hatching success was lower for relocated nests in five of seven cases with an average decrease for all seven sites of 5.01 percent (range = 7.19 percent increase to 16.31 percent decrease). Emergence success was lower for relocated nests in all seven cases by an average of 11.67 percent (range = 3.6 to 23.36 percent) (Meylan 1995).

2. Equipment

The placement of pipelines and the use of heavy machinery on the beach during a construction project may also have adverse effects on sea turtles. They can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls and unnecessary energy expenditure.

3. Artificial lighting

Visual cues are the primary sea-finding mechanism for hatchling sea turtles (Mrosovsky and Carr 1967, Mrosovsky and Shettleworth 1968, Dickerson and Nelson 1989, Witherington and Bjorndal 1991). When artificial lighting is present on or near the beach, it can misdirect hatchlings once they emerge from their nests and prevent them from reaching the ocean (Philibosian 1976; Mann 1977; Florida Fish and Wildlife Conservation Commission, unpublished data). In addition, a significant reduction in sea turtle nesting activity has been documented on beaches illuminated with artificial lights (Witherington 1992). Therefore, construction lights along a project beach and on the dredging vessel may deter females from coming ashore to nest, misdirect females trying to return to the surf after a nesting event, and misdirect emergent hatchlings from adjacent non-project beaches. Any source of bright lighting can profoundly affect the orientation of hatchlings, both during the crawl from the beach to the ocean and once they begin swimming offshore. Hatchlings attracted to light sources on dredging barges may not only suffer from interference in migration, but may also experience higher probabilities of predation to predatory fishes that are also attracted to the barge lights. This impact could be reduced by using the minimum amount of light necessary (may require shielding) or low pressure sodium lighting during project construction.

Indirect Effects

Many of the direct effects of beach nourishment may persist over time and become indirect impacts. These indirect effects include increased susceptibility of relocated nests to catastrophic events, the consequences of potential increased beachfront development, changes in the physical characteristics of the beach, the formation of escarpments, and future sand migration.

1. Increased susceptibility to catastrophic events
Nest relocation may concentrate eggs in an area making them more susceptible to catastrophic events. Hatchlings released from concentrated areas also may be subject to greater predation rates from both land and marine predators, because the predators learn where to concentrate their efforts (Glenn 1998, Wyneken *et al.* 1998).

2. Increased beachfront development
Pilkey and Dixon (1996) state that beach replenishment frequently leads to more development in greater density within shorefront communities that are then left with a future of further replenishment or more drastic stabilization measures. Dean (1999) also notes that the very existence of a beach nourishment project can encourage more development in coastal areas. Following completion of a beach nourishment project in Miami during 1982, investment in new and updated facilities substantially increased tourism there (National Research Council 1995). Increased building density immediately adjacent to the beach often resulted as older buildings were replaced by much larger ones that accommodated more beach users. Overall, shoreline management creates an upward spiral of initial protective measures resulting in more expensive development which leads to the need for more and larger protective measures. Increased shoreline development may adversely affect sea turtle nesting success. Greater development may support larger populations of mammalian predators, such as foxes and raccoons, than undeveloped areas (National Research Council 1990a), and can also result in greater adverse effects due to artificial lighting, as discussed above.

3. Changes in the physical environment
Beach nourishment may result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, sand grain size, sand grain shape, and sand grain mineral content if the placed sand is dissimilar from the original beach sand (Nelson and Dickerson 1988a). These changes could result in adverse impacts on nest site selection, digging behavior, clutch viability, and emergence by hatchlings (Nelson and Dickerson 1987, Nelson 1988).

Beach compaction and unnatural beach profiles that may result from beach nourishment activities could negatively impact sea turtles regardless of the timing of projects. Very fine sand and/or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson *et al.* 1987, Nelson and Dickerson 1988a). Significant reductions in nesting success (i.e., false crawls occurred more frequently) have been documented on severely compacted nourished beaches (Fletemeyer 1980, Raymond 1984, Nelson and Dickerson 1987, Nelson *et al.* 1987), and increased false crawls may result in increased physiological stress to nesting females. Sand compaction may increase the length of time required for female sea turtles to excavate nests and also cause increased physiological stress to the animals (Nelson and Dickerson 1988c). Nelson and Dickerson (1988b) concluded that, in general, beaches nourished from offshore borrow sites are harder than natural beaches, and while some may soften over time through erosion and accretion of sand, others may remain hard for 10 years or more.

These impacts can be minimized by using suitable sand and by tilling compacted sand after project completion. The level of compaction of a beach can be assessed by measuring sand compaction using a cone penetrometer (Nelson 1987). Tilling of a nourished beach with a root rake may reduce the sand compaction to levels comparable to unnourished beaches. However, a pilot study by Nelson and Dickerson (1988c) showed that a tilled nourished beach will remain uncompacted for up to 1 year. Therefore, the Service requires multi-year beach compaction monitoring and, if necessary, tilling to ensure that project impacts on sea turtles are minimized.

A change in sediment color on a beach could change the natural incubation temperatures of nests in an area, which, in turn, could alter natural sex ratios. To provide the most suitable sediment for nesting sea turtles, the color of the nourished sediments must resemble the natural beach sand in the area. Natural reworking of sediments and bleaching from exposure to the sun would help to lighten dark nourishment sediments; however, the timeframe for sediment mixing and bleaching to occur could be critical to a successful sea turtle nesting season.

4. Escarpment formation
On nourished beaches, steep escarpments may develop along their water line interface as they adjust from an unnatural construction profile to a more natural beach profile (Coastal Engineering Research Center 1984, Nelson *et al.* 1987). These escarpments can hamper or prevent access to nesting sites (Nelson and Blihovde 1998). Researchers have shown that female turtles coming ashore to nest can be discouraged by the formation of an escarpment, leading to situations where they choose marginal or unsuitable nesting areas to deposit eggs (e.g., in front of the escarpments, which often results in failure of nests due to prolonged tidal inundation). This impact can be minimized by leveling any escarpments prior to the nesting season.

5. Erosion
Future sand displacement on nesting beaches is a potential effect of the nourishment project. Dredging of sand offshore from a project area has the potential to cause erosion of the newly created beach or other areas on the same or adjacent beaches by creating a sand sink. The remainder of the system responds to this sand sink by providing sand from the beach to attempt to reestablish equilibrium (National Research Council 1990b).

Species' response to a proposed action

Ernest and Martin (1999) conducted a comprehensive study to assess the effects of beach nourishment on loggerhead sea turtle nesting and reproductive success. The following findings illustrate sea turtle responses to and recovery from a nourishment project. A significantly larger proportion of turtles emerging on nourished beaches abandoned their nesting attempts than turtles emerging on Control or pre-nourished beaches. This reduction in nesting success was most pronounced during the first year following project construction and is most likely the result of changes in physical beach characteristics associated with the nourishment project (e.g., beach profile, sediment grain size, beach compaction, frequency and extent of escarpments). During the first post-construction year, the time required for turtles to excavate an egg chamber on the untilled, hard-packed sands of one treatment area increased significantly relative to Control and background conditions. However, in another treatment area, tilling was effective in reducing sediment compaction to levels that did not significantly prolong digging times. As natural processes reduced compaction levels on nourished beaches during the second post-construction year, digging times returned to background levels.

During the first post-construction year, nests on the nourished beaches were deposited significantly farther from both the toe of the dune and the tide line than nests on Control beaches. Furthermore, nests were distributed throughout all available habitat and were not clustered near the dune as they were in the Control. As the width of nourished beaches decreased during the second year, among-treatment differences in nest placement diminished. More nests were washed out on the wide, flat beaches of the nourished treatments than on the narrower steeply sloped beaches of the Control. This phenomenon persisted through the second post-construction year monitoring and resulted from the placement of nests near the seaward edge of the beach berm where dramatic profile changes, caused by erosion and scarping, occurred as the beach equilibrated to a more natural contour.

As with other beach nourishment projects, Ernest and Martin (1999) found that the principal effect of nourishment on sea turtle reproduction was a reduction in nesting success during the first year following project construction. Although most studies have attributed this phenomenon to an increase in beach compaction and escarpment formation, Ernest and Martin indicate that changes in beach profile may be more important. Regardless, as a nourished beach is reworked by natural processes in subsequent years and adjusts from an unnatural construction profile to a more natural beach profile, beach compaction and the frequency of escarpment formation decline, and nesting and nesting success return to levels found on natural beaches.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. The Service is not aware of any cumulative effects in the project area.

CONCLUSION

After reviewing the current status of the loggerhead, green, hawksbill, and leatherback turtle, the environmental baseline for the action area, the effects of the proposed beach nourishment, and the cumulative effects, it is the Service's biological opinion that the beach nourishment project, as proposed, is not likely to jeopardize the continued existence of the loggerhead, green, hawksbill, and leatherback turtle, and is not likely to destroy or adversely modify designated critical habitat. No critical habitat has been designated for the loggerhead, green, hawksbill, and leatherback turtle, in the continental United States; therefore, none will be affected.

The proposed project will affect only 7.6 miles of the approximately 1,400 miles of available sea turtle nesting habitat in the southeastern U.S. Research has shown that the principal effect of beach nourishment on sea turtle reproduction is a reduction in nesting success, and this reduction is most often limited to the first year following project construction. Research has also shown that the impacts of a nourishment project on sea turtle nesting habitat are typically short-term because a nourished beach will be reworked by natural processes in subsequent years, and beach compaction and the frequency of escarpment formation will decline. Although a variety of factors, including some that cannot be controlled, can influence how a nourishment project will perform from an engineering perspective, measures can be implemented to minimize impacts to sea turtles.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered or threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be implemented by the CORPS so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The CORPS has a continuing duty to regulate the activity covered by this incidental take statement. If the CORPS (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the CORPS must report the progress of the action and its impacts on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The Service anticipates 7.6 miles of nesting beach habitat could be taken as a result of this proposed action. The take is expected to be in the form of: (1) destruction of all nests that may be constructed and eggs that may be deposited from March 1 through April 30 and from September 1 through September 30 and missed by a nest survey and egg relocation program within the boundaries of the proposed project; (2) destruction of all nests deposited from October 1 through February 28 (or 29 as applicable) when a nest survey and egg relocation program is not required to be in place within the boundaries of the proposed project; (3) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (4) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (5) misdirection of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting; (6) behavior modification of nesting females due to escarpment formation within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; and (7) destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Fish and Wildlife Service.

Incidental take is anticipated for only the 7.6 miles of beach that has been identified for sand placement. The Service anticipates incidental take of sea turtles will be difficult to detect for the following reasons: (1) the turtles nest primarily at night and all nests are not found because [a] natural factors, such as rainfall, wind, and tides may obscure crawls and [b] human-caused factors, such as pedestrian and vehicular traffic, may obscure crawls, and result in nests being destroyed because they were missed during a nesting survey and egg relocation program; (2) the total number of hatchlings per undiscovered nest is unknown; (3) the reduction in percent hatching and emerging success per relocated nest over the natural nest site is unknown; (4) an unknown number of females may avoid the project beach and be forced to nest in a less than optimal area; (5) lights may misdirect an unknown number of hatchlings and cause death; and (6) escarpments may form and cause an unknown number of females from accessing a suitable nesting site. However, the level of take of these species can be anticipated by the disturbance and renourishment of suitable turtle nesting beach habitat because: (1) turtles nest within the project site; (2) beach renourishment will likely occur during a portion of the nesting season; (3) the renourishment project will modify the incubation substrate, beach slope, and sand compaction; and (4) artificial lighting will deter and/or misdirect nesting females and hatchlings.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species. Critical habitat has not been designated in the project area; therefore, the project will not result in destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of loggerhead, green, hawksbill, and leatherback sea turtles.

1. Beach quality sand suitable for sea turtle nesting, successful incubation, and hatchling emergence must be used on the project site.

2. Beach nourishment activities must not occur from May 1 through October 31, the period of peak sea turtle egg laying and egg hatching, to reduce the possibility of sea turtle nest burial or crushing of eggs.

3. If the beach nourishment project will be conducted during the period from March 1 through April 30, surveys for early nesting sea turtles must be conducted. If nests are constructed in the area of beach nourishment, the eggs must be relocated.

4. If the beach nourishment project will be conducted during the period from November 1 through November 30, surveys for late nesting sea turtles must be conducted. If nests are constructed in the area of beach nourishment, the eggs must be relocated.

5. Immediately after completion of the beach nourishment project and prior to the next three nesting seasons, beach compaction must be monitored and tilling must be conducted as required by March 1 to reduce the likelihood of impacting sea turtle nesting and hatching activities. The

March 1 deadline is required to reduce impacts to leatherbacks that nest in greater frequency along the South Atlantic coast of Florida than elsewhere in the continental United States.

6. Immediately after completion of the beach nourishment project and prior to the next three nesting seasons, monitoring must be conducted to determine if escarpments are present and escarpments must be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities.

7. The applicant must ensure that contractors doing the beach nourishment work fully understand the sea turtle protection measures detailed in this incidental take statement.

8. During the early and late portions of the nesting season, construction equipment and pipes must be stored in a manner that will minimize impacts to sea turtles to the maximum extent practicable.

9. During the early and late portions of the nesting season, lighting associated with the project must be minimized to reduce the possibility of disrupting and misdirecting nesting and/or hatchling sea turtles.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the CORPS must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. All fill material placed must be sand that is similar to a native beach in the vicinity of the site that has not been affected by prior renourishment activities. The fill material must be similar in both coloration and grain size distribution to the native beach. All such fill material must be free of construction debris, rocks, or other foreign matter and must not contain, on average, greater than 10 percent fines (i.e., silt and clay) (passing the #200 sieve) and must not contain, on average, greater than 5 percent coarse gravel or cobbles, exclusive of shell material (retained by the #4 sieve).

2. Beach nourishment must be started after October 31 and be completed before May 1. During the May 1 through October 31 period, no construction equipment or pipes will be stored on the beach.

3. If the beach nourishment project will be conducted during the period from March 1 through April 30, daily early morning surveys for sea turtle nests must be conducted from March 1 through April 30 or until completion of the project (whichever is earliest), and eggs must be relocated per the following requirements.

3a. Nesting surveys and egg relocations will only be conducted by personnel with prior experience and training in nesting survey and egg relocation procedures. Surveyors must have a valid Florida Fish and Wildlife Conservation Commission permit. Nesting surveys must be conducted daily between sunrise and 9 a.m. Surveys must be performed in such a manner so as to ensure that construction activity does not occur in any location prior to completion of the necessary sea turtle protection measures.

3b. Only those nests that may be affected by construction activities will be relocated. Nests requiring relocation must be moved no later than 9 a.m. the morning following deposition to a nearby self-release beach site in a secure setting where artificial lighting will not interfere with hatchling orientation. Nest relocations in association with construction activities must cease when construction activities no longer threaten nests. Nests deposited within areas where construction activities have ceased or will not occur for 65 days must be marked and left in place unless other factors threaten the success of the nest. Any nests left in the active construction zone must be clearly marked, and all mechanical equipment must avoid nests by at least 10 feet.

4. If the beach nourishment project will be conducted during the period from November 1 through November 30, daily early morning sea turtle nesting surveys must be conducted 65 days prior to project initiation and continue through September 30, and eggs must be relocated per the preceding requirements.

5. Immediately after completion of the beach nourishment project and prior to March 1 for 3 subsequent years, sand compaction must be monitored in the area of restoration in accordance with a protocol agreed to by the Service, the State regulatory agency, and the applicant. At a minimum, the protocol provided under 5a and 5b below must be followed. If required, the area must be tilled to a depth of 36 inches. All tilling activity must be completed prior to March 1. An annual summary of compaction surveys and the actions taken must be submitted to the Service. (NOTE: The requirement for compaction monitoring can be eliminated if the decision is made to till regardless of post-construction compaction levels. Also, out-year compaction monitoring and remediation are not required if placed material no longer remains on the beach.)

5a. Compaction sampling stations must be located at 500-foot intervals along the project area. One station must be at the seaward edge of the dune/bulkhead line (when material is placed in this area), and one station must be midway between the dune line and the high water line (normal wrack line).

At each station, the cone penetrometer will be pushed to a depth of 6, 12, and 18 inches three times (three replicates). Material may be removed from the hole if necessary to ensure accurate readings of successive levels of sediment. The penetrometer may need to be reset between pushes, especially if sediment layering exists. Layers of highly compact material may lay over less compact layers. Replicates will be located as close to each other as possible, without interacting with the previous hole and/or disturbed sediments. The three replicate compaction values for each depth will be averaged to produce final values for each depth at each station. Reports will include all 18 values for each transect line, and the final 6 averaged compaction values.

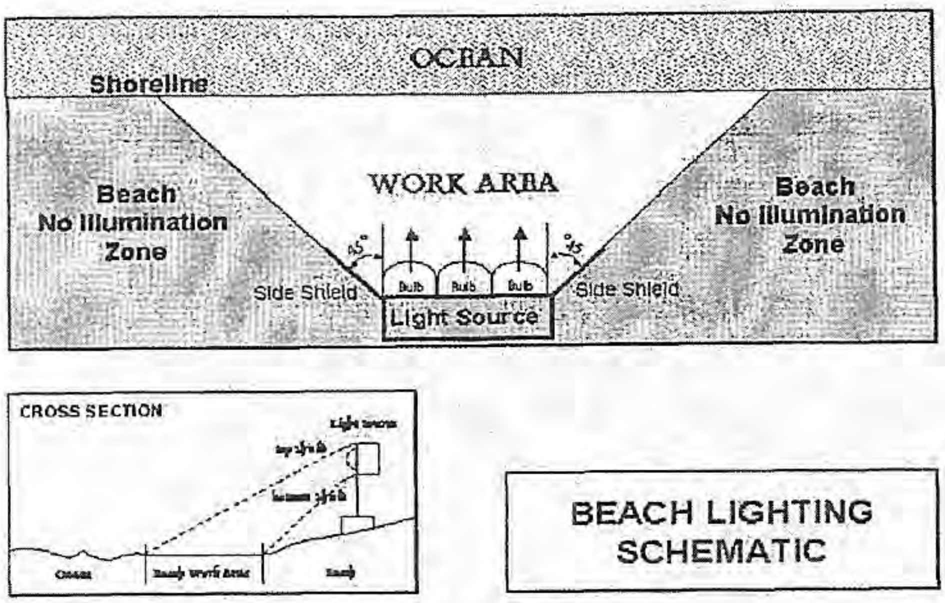
5b. If the average value for any depth exceeds 500 pounds per square inch (psi) for any two or more adjacent stations, then that area must be tilled prior to March 1. If values exceeding 500 psi are distributed throughout the project area but in no case do those values exist at two adjacent stations at the same depth, then consultation with the Fish and Wildlife Service will be required to determine if tilling is required. If a few values exceeding 500 psi are present randomly within the project area, tilling will not be required.

6. Visual surveys for escarpments along the project area must be made immediately after completion of the beach nourishment project and prior to March 1 for 3 subsequent years. Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet must be leveled to the natural beach contour by March 1. If the project is completed during the early part of the sea turtle nesting and hatching season (March 1 through April 30), escarpments may be required to be leveled immediately, while protecting nests that have been relocated or left in place. The Service must be contacted immediately if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service will provide a brief written authorization that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken must be submitted to the Service. (NOTE: Out-year escarpment monitoring and remediation are not required if placed material no longer remains on the dry beach.)

7. The applicant must arrange a meeting between representatives of the contractor, the Service, the Florida Fish and Wildlife Conservation Commission, and the permitted person responsible for egg relocation at least 30 days prior to the commencement of work on this project. At least 10 days advance notice must be provided prior to conducting this meeting. This will provide an opportunity for explanation and/or clarification of the sea turtle protection measures.

8. From March 1 through April 30 and November 1 through November 30, staging areas for construction equipment must be located off the beach to the maximum extent practicable. Nighttime storage of construction equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. In addition, all construction pipes that are placed on the beach must be located as far landward as possible without compromising the integrity of the existing or reconstructed dune system. Temporary storage of pipes must be off the beach to the maximum extent possible. Temporary storage of pipes on the beach must be in such a manner so as to impact the least amount of nesting habitat and must likewise not compromise the integrity of the dune systems (placement of pipes perpendicular to the shoreline is recommended as the method of storage).

9. From March 1 through April 30 and November 1 through November 30, direct lighting of the beach and near shore waters must be limited to the immediate construction area and must comply with safety requirements. Lighting on offshore or onshore equipment must be minimized through reduction, shielding, lowering, and appropriate placement to avoid excessive illumination of the waters surface and nesting beach while meeting all Coast Guard, EM 385-1-1, and OSHA requirements. Light intensity of lighting plants must be reduced to the minimum standard required by OSHA for General Construction areas, in order not to misdirect sea turtles. Shields must be affixed to the light housing and be large enough to block light from all lamps from being transmitted outside the construction area (see diagram below).



BEACH LIGHTING SCHEMATIC

10. A report describing the actions taken to implement the terms and conditions of this incidental take statement must be submitted to the Jacksonville Field Office within 60 days of completion of the proposed work for each year when the activity has occurred. This report will include the dates of actual construction activities, names and qualifications of personnel involved in nest surveys and relocation activities, descriptions and locations of self-release beach sites, nest survey and relocation results, and hatching success of nests.

11. In the event a sea turtle nest is excavated during construction activities, the permitted person responsible for egg relocation for the project must be notified so the eggs can be moved to a suitable relocation site.

12. Upon locating a sea turtle adult, hatchling, or egg harmed or destroyed as a direct or indirect result of the project, notification must be made to the Florida Fish and Wildlife Conservation Commission at 1-888-404-3922 and Jacksonville Field Office at (904) 232-2580. Care should be taken in handling injured turtles or eggs to ensure effective treatment or disposition, and in handling dead specimens to preserve biological materials in the best possible state for later analysis.

The Service believes that incidental take will be limited to the 7.6 miles of beach that have been identified for sand placement. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that no more than the following types of incidental take will result from the proposed action: (1) destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey and egg relocation program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey and egg relocation program is not required to be in place within the boundaries of the proposed project; (3) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (4) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (5) disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting; (6) behavior modification of nesting females due to escarpment formation within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; and (7) destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Fish and Wildlife Service. The amount or extent of incidental take for sea turtles will be considered exceeded if the project results in more than a one-time placement of sand on the 7.6 miles of beach that have been identified for sand placement. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The CORPS must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a) (1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Sebellarid worm rock reef monitoring in the mid reach area should be conducted for three years. Details for monitoring the reef will follow on a separate cover.

2. Appropriate native salt-resistant dune vegetation should be established on the restored dunes. The Florida Department of Environmental Protection, Bureau of Beaches and Wetland Resources, can provide technical assistance on the specifications for design and implementation.

3. Surveys for nesting success of sea turtles should be continued for a minimum of 3 years following beach nourishment to determine whether sea turtle nesting success has been adversely impacted.

4. Educational signs should be placed where appropriate at beach access points explaining the importance of the area to sea turtles and/or the life history of sea turtle species that nest in the area.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If you have any questions regarding this biological opinion, please contact Ann Marie Maharaj of this office at (904) 232-2580 ext 111.

Sincerely,

Stephen L. Smith

for David L. Hankla
Field Supervisor

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Fish and Wildlife Resources

We submit the following comments in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*)

In addition to sea turtles, the beaches of Brevard County support an active shorebird nesting, roosting, and/or feeding habitat. The bird species that may occur within the project area include the Federally listed Piping plover (*Charadrius melodus*), also State-listed, Snowy plover (*Charadrius alexandrinus*), Least tern (*Sterna antillarum*), and Roseate tern (*Sterna dougalli dougallii*), also State-listed, The species of special concern that may occur within the project area include the American oystercatcher (*Haematopus palliates*), Brown pelican (*Pelecanus occientalis*), and the Black Skimmer (*Rynchops niger*).

The Service recommends that the applicant implement the following measures to avoid potential impacts to shorebirds and their nesting colony by:
(1) Ensuring that construction activity or storage of equipment will not occur on the beach north of the project area.
(2) Implementing a 300-foot buffer zone around any locations within the project area where shorebirds have been engaged in courtship or nesting behavior.
(3) Increasing the buffer zone size in the event that the shorebirds continue to demonstrate agitated behavior as a result of construction activities.
(4) Posting shorebird nesting sites per Florida Fish and Wildlife Conservation Commission (FWC) specifications.

In addition, the DEP permit indicates that daily shorebird surveys by authorized personnel will be conducted from April 1 through September 1 (or 45 days prior to construction) during the year of construction and for one nesting season post-construction. The surveys will be conducted by trained individuals using approved ecological survey procedures (e. g., the U. S. Geological Survey's Breeding Season Population Census Techniques for Seabirds and Colonial Waterbirds throughout North America.

The nearshore rock outcrops along the Mid-Reach are principally composed of tabular lithifed coquina (limestone) ledges. The ledges typically exhibit a slight landward strike upward toward the beach; i.e., a slight upward inclination of the landward edge. The physical relief and density of the rock varies significantly along the 8.6+ miles of shoreline where the rock occurs, decreasing in extent and physical complexity toward the south.

A summary of the biological aspects of the rock hardground presented in the Service, Coordination Act Report (USFWS, 1995). The Service stated that the coquina rock outcrops and scattered live worm rock reef "is important for two reasons: (1) it supports a stable and complex community of species [from amphipods to crustaceans to fish, and macroalgae], and (2) functions as an offshore breakwater and sediment trap for suspended sediments which may act to prograde beaches."
The rock is exposed as both singular, isolated outcrops and large tabular ledges, where the latter are generally fractured, pitted, uplifted or otherwise irregular. The vertical relief typically varies from 0" (flush with the sand seabed) to 18", with some instances of up to 30" relief. Some of the rock surfaces feature patchy or dense algae, others are barren.

The nearshore rock occurs in a narrow band immediately along and below the low tide shoreline at seabed depths of about +1 to -3 ft mean low water (about -1 to -5 ft ngvd). The rock extends up to about 280 feet from the mean low water shoreline along the northern Mid-Reach, and generally extends less than about 120 feet from the mean low water shoreline along the southern Mid-Reach. Sabellariid worm rock develops as scattered mounds atop the coquina rock outcrops. This rock is created by colonies of the tube-building polychaete (*Phragmatopoma lapidosa)*. These worms thrive in the turbid warm waters of the surf zone, catching and filtering sand and secreting it to form the tubes in which they live. Along the Mid-Reach, some worm colonies are exposed at low tide while some mounds remain always submerged. The worm colony abundance is highly variable. Storm waves are known to dislodge and almost completely eradicate the worm colonies in this area. The worm colonies re-develop in subsequent years, particularly in warmer summer months and apparently in similar locations and abundance as in pre-storm conditions.

According to the Continental Shelf Associates, Inc. (CSA, 1990) report, the presence of nearshore rock outcrops, including sabellariid worm rock, is between R59 and R115, with the principal outcrops between R78 and R93. The outcrops between R78 and R93 were said to be well-defined ledges with 2 to 3 ft of vertical relief and *Caulerpa prolifera* (algae). Rock outcropping between R94 and R110 was said to exhibit lower vertical relief but was still well developed.

Nearshore rock density is greatest at the north end of the Mid Reach and decreases significantly from north to south. The nearshore hard bottom is mostly low-relief coquina rock ledges that are intermittently exposed above the sand along and below the low-tide shoreline in water depths of 0 to 4 feet (low tide). This project proposes to impact 10 acres of hard bottom. The rock that may potentially offer "higher-value" habitat is estimated as about half of the total acreage, and is distributed alongshore similarly to that of the total. Areas containing some level of probable sabellarriid "worm rock" totaled about 1.6 to 2.5 acres, or 2.6% to 4.1% of the total rock acreage (mostly between R-85 and R-92, and between R-96 and R-101). The abundance of rock decreases significantly from north to south along the Mid Reach. The highest concentration of rock occurs along the northern 1.1-miles of the Mid-Reach (R74-R82), which includes about 45% of the total 60.8-acre estimate. The northern 4.1-miles of the Mid Reach comprise about 75% of the total rock acreage.

At the proposed nearshore project area, strict *in-kind* mitigation of the rock resources cannot be feasibly constructed. The proposed mitigation consists of *Near-kind* mitigation, consisting of rock-reef structures, placed in depths greater than about 17 to 20 ft (mlw). An engineered mattress foundation would be required.

The Service recommends avoiding impacts to the hard bottom between R-Monument 75.4 to R-Monument 99 by nourishing only the dune areas along this shoreline until a study of the function and value of the artificial reef is conducted. The Service recommends minimum-scale truck-haul nourishment between R-Monument 99 to R-Monument 109.4. These areas should be nourished no more than 100 feet from the mean low water line to minimize impacts to hard bottom to the maximum extent practicable. The Service recommends conventional hydraulic beach fill from R-Monument 109.4 to R-Monument 118.8. The impacts to the hard bottom in this area would total 1.7 acres of impacts. The impacts should be mitigated by the artificial reef at a ratio of 1:4. If after study of the artificial reef's function and value, the artificial reef did not provide in-kind function and value of the hard bottom impacts, an alternative compensation should be discussed for the areas of the nearshore reef that were impacted.

We look forward to coordinating with you on this project. Thank you for the opportunity to comment in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*). If you have any further questions or would like to discuss our comments, please feel free to contact Ann Marie Maharaj at (904) 232-2580 ext. 111.

Appendix C

NOAA Fisheries-NMFS 2008 Comments to the Service on the Draft FWCAR

Mr. David L. Hankla
U.S. Fish and Wildlife Service
6620 Southpoint Drive South #310
Jacksonville, FL 32216
Attn: Ann Marie Lauristen

Dear Mr. Hankla:

NOAA's National Marine Fisheries Service (NMFS) has reviewed U.S. Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act Report (FWCAR) for the Brevard County's Mid-Reach Shore Protection Project located in Brevard County, Florida, dated March 18, 2008, and received electronically April 1, 2008. As stated, The Mid-Reach Study was authorized by Section 418 of the Water Resources and Development Act of 2000 (Public Law 106-541). In cooperation with Brevard County, the Corps has evaluated over 90 alternatives. For planning purposes, the Corps divided the Mid-Reach into six segments or "reaches" with the southern most reach being labeled "1" and the northern most being "6". This FWCAR focuses on the Corps' tentatively selected plan know as the National Economic Development (NED) Plan, and the Locally Preferred Plan (LPP) put forth by the project's local sponsor, Brevard County. Proposed project impacts would be to FWS designated Resource Category 1 and areas identified as EFH-Habitat Areas of Particular Concern by NMFS and the South Atlantic Fisheries Management Council.

The NED (referred to by the Corps as Alternative 55) would extend the mean high water 10 feet waterward, and would include advanced nourishment to maintain that design fill volume in Reaches 1 through 5; and a dune fill with no added advanced nourishment in Reach 6. Fill material would be dredged from Canaveral Shoals and placed at the Poseidon DMMA, Port Canaveral, and then hauled by truck to the Mid-Reach for placement on the beach at approximately 3-year intervals. The NED plan would result in **direct** and **continual** burial of 2.57 acres of nearshore hard bottom and worm reef habitat. This is an areal estimation interpreted from aerial photography. The LPP differs from the NED plan in Reach 1 where construction of an conventional fill 90-foot wide mean high water extension would taper to 10-foot wide mean high water line (MHWL) extension in Reach 2. The remainder is the same as alternative 55 with a 10-foot MHWL water extension in Reaches 2 to 5 and a dune fill in Reach 6. The estimated direct nearshore hard bottom and worm reef habitat for this plan is 3.0 acres, again based on surface estimates derived from of aerial photography, with no accounting for indirect impacts.

The mitigation plan calls for the placement of prefabricated articulated concrete mats imbedded with natural coquina stone at a 1 to 2.81 impact to mitigation ratio. The relief of these mats would be similar to the low-lying natural rock formations but they would be placed approximately 300 m or 1000 ft seaward of the natural nearshore rock between the 14 to 16 foot water depth contour lines in an unspecified area along the 7.78 miles of mid-reach.

NMFS concurs with the well-researched conclusions and supports the recommendations provided by the FWS provided on pages 30, 33 and 34 of the FWCAR, and would include the following:

Habitat (referenced in pages 33,18,14)

NMFS would emphasis that, "The nearshore hard bottom of the Mid-Reach represents a unique habitat of very limited quantity along the Atlantic coast. It is considered a priority 'resource' within the project area supporting the epibenthos, macroalgae, invertebrates, turtles, fishes, birds and recreational fishers. Key ecological services provided by nearshore hard bottom include substrate, shelter, habitat connectivity, feeding sites, nesting sites, and nursery areas. This resource and the associated species in their appropriate life stages are considered by the Service to be in Resource Category 1, and no loss of habitat value of these unique and limited areas is recommended." (P.33)

The importance of these habitats is made clear by the studies cited in the FWCAR, page 18. "These habitats studied in Indian River and Martin Counties revealed more than 300 invertebrates, 192 fish species, and over 100 marine algae species depend on the reefs and associated resources for development and survival (Nelson and Demetriades, 1992; Juett et al., 1976; Nelson, 1989, Lindeman and Snyder 1999). The nearshore reefs support high densities of juvenile fishes in areas otherwise devoid of any substantial three-dimensional structural habitats. These habitats are important recruitment and nursery areas for a diverse marine fauna and flora, including rare taxa and important fishery species. For example, in the U.S., the striped croaker (*Bairdiella sanctaeluciae*) is limited only to nearshore reef formations of east Florida. (EDO 2000).

Lindeman and Snyder (1999) suggested that nearshore hardbottom serves a primary nursery role for incoming early life stages of fish that would experience higher predation mortality without shelter. It may also provide secondary nursery habitat for juveniles that emigrate out of inlets towards offshore reefs. Some species use these structures as resident nurseries, settling, growing-out, and maturing sexually as permanent residents (e. g. pomacentrids, labrisomids). An additional nursery role may result from increased growth due to higher food availabilities in these structure-rich environments.

Nearshore reefs also provide important feeding and shelter areas for juvenile endangered green sea turtles (Ehrhart 1992, Dynamac 2005). The reef system is important for several reasons including the support of a stable and complex community of species and the modification and stabilization of beach sediments (Zale and Merrifield 1989, Wells 1970). It has been suggested that sabellarids may have been instrumental in the construction and preservation of beaches in the geologic past and that beach rock, converted from the reefs and impoundment of sediment on their landward side, provide for progradation of the beach (Kirtley and Tanner 1968). Gore et al. (1978) reported numerous invertebrate worm reef inhabitants to include amphipods, isopods, decapods, penaid shrimp, stomatopod, crustaceans including the porcellanid crab (Pachycheles monilifer), the zanthid crab (Menippe nodifrons) and the grasped crab (Pachygrapus transverses). (P.18)

In addition to the ecological functions provided by the nearshore hard bottom it is important to note that, large sections of the nearshore reef in Brevard County are composed of "worm rock". These rock structures are formed by the reef-building sabellariid worm, *Phragmatapoma lapidosa*; originally described by Kirtley and Tanner (1968). Similar hard bottom habitats studied in Indian River and Martin Counties revealed that more than 300 invertebrates, 192 fish species, and over 100 marine algae species utilize the reefs and associated resources for development and survival (Nelson and Demetriades, 1992; Juett et al., 1976; Nelson, 1989). In addition to these taxa, federally listed marine turtles have also been found to utilize the rock resources (Ehrhart, 1992)

Littoral Drift / Sand Budget (page 14)

The need to address deficits in the historical sand budget which was continuously supplemented by littoral drift sand may in fact represent the most important component of a comprehensive, long-term solution to high erosional rates within Brevard's Mid-reach. Given that in natural coastal systems there is a sediment equilibrium marked by dynamic exchange of sand between offshore bars, beaches and dunes, large long-term deficits in the equilibrium of this budget will be corrected through shifts in the source dynamics. It is known that since Port Canaveral creation in 1951, new water and wind patterns were created which reversed the original southerly drift of sand along the Atlantic shoreline. This aggravated erosion of the beaches south of the jetties and build up of beaches to the north. As the sediment budget in the Mid-reach was subsequently reduced, equilibrium dynamics sought to replace losses offshore and on the beach with sand from the upland dune. Only since 2007 has it been documented that various strategies employed by the Port Authority and Corps have resulted in by-passing an amount of sand equivalent to that being blocked by the Port's jetties. However, issues still remain about how much, how often and where by-pass sand can best incorporated into the littoral system to the south. Further even if current efforts only kept pace with ongoing blockage rates, there is a 50+ year sand deficit that will continue to alter geological littoral processes along the Mid-reach. Given the proposed nourishment amount, even at three- year intervals, it is doubtful that rates of upland dune erosion will be abated. Finally, given that both proposed plans would impact areas where the size and abundance of *P. Lapisdosa* colonies are the greatest, the important function of this specie to "modify and stabilize beach sediments" would be impaired resulting in additional beach and subsequently upland dune erosion.

The FWCAR only briefly mentions this issue (p.14) using conclusions from a 2006 Corps study, "…the creation of Port Canaveral changed the natural littoral drift transport patterns along some sections of the central Brevard beaches and exacerbates natural current drift (Corps 1996)". Similar effects, disrupted sand transfer dynamics and long-shore equilibriums, as well as sand budget deficits, are systemic at many constructed inlets along the Atlantic east coast and this issues should be addressed by the Corps through a Programmatic Environmental Impact Statement (PEIS).

Mitigation

Since Brevard's Mid-reach is comprised of a Resource Category 1, a unique habitat of very limited quantity and area, it is clear from the FWCAR that the Service will recommend no loss of habitat value. Similarly, if this project is approved permanent impacts to EFH-HAPC will occur, and both NMFS and the Service must be assured that the sequential mitigation process (avoidance, minimization and then mitigation) results in no loss habitat value / ecological function. In order for this to occur, the Corps and local sponsor will have to establish; that all practicable steps to avoid and minimize impacts have been taken, an accurate assessment of the proposed impacts, establish the habitat value and significance of the ecology processes that would be loss, and provide mitigation that would replace those functions and processes.

In regard to these issues, No estimates of the project's total direct impacts, which would include vertical relief, underside of ledges and interstitial spaces, nor the project's indirect impacts related to turbidity, sedimentation and a margin of error fill outside the "anticipated equilibrium profile" have been provided.

No discussion of the how the loss of this nearshore rock area and trough (between the edge of the near shore rock formation and beach-"Swash Zone") might effect larvae emigrating from the lagoon or along the coast. As stated on Page 18, Lindeman and Snyder (1999) suggested that nearshore hardbottom serves a primary nursery role for incoming early life stages of fish that would experience higher predation mortality without shelter. It may also provide secondary nursery habitat for juveniles that emigrate out of inlets towards offshore reefs. Some species use these structures as resident nurseries, settling, growing-out, and maturing sexually as permanent residents (e. g. pomacentrids, labrisomids). An additional nursery role may result from increased growth due to higher food availabilities in these structure-rich environments.

In regard to minimization of impacts to fish species it is important to note that (P. 20), "Fish distribution varied along the Mid-Reach with generally higher numbers of species and individuals at the northernmost sites and progressively fewer along the shore in a southerly direction. Specific sampling sites that were species-rich (Sunrise Avenue in Reach 4 and Paradise Park in Reach 1) also had greater hard bottom areal coverage (Olsen 2003)." This would imply that a project reduced in size that weighted impacts to the southern portion of the Mid-reach may have less impact.

If mitigation is provide refugee must be functioning/habitable environment not a FAD Mitigation reef form – low-relief articulated mats may not provided sufficient replacement given that (P. 18), "CSA (2005) suggested that complexity in the form of undercut ledges and gulleys in the rock formations could be more important than overall areal coverage in determining species richness.

Problems with proposed mitigation

If mitigation reef is to have any measure of success it is clear that timing (pre-construction so as to provide established, similar, refugee habitat is available) and proximity to impact are critical

Lindeman and Snyder (1999) evaluated a similar nearshore impact in south Florida; however the mitigation reef was not constructed until three years after the renourishment occurred. Many factors can limit net biomass productivity. However it was concluded that if the artificial reefs were constructed prior to burial of the natural reef and located at similar depths, mitigation reefs may have provided a refuge for a sizeable fraction of the thousands of displaced fishes during the burial of that hardbottom reef, as well as thousands of subsequent new recruits. This study emphasized the importance of depth and timing.
Depending on displaced fish to find and use corridors may not have same result.

Proposed mitigation would be placed too far from impacted area for it to be effective- 300 m or 1000 ft seaward from the edge of existing hard bottom. Predation of fleeing juveniles likely.

Pilot Study

McCarthy and Holloway's/Brevard's pilot study placed in 15 ft of water did show recruitment by little to no survival. This suggests that For P. *Lapisdosa* depth and temperature of substrate a factor to survival of worms this northern most extent of their range. Further, worms rely on suspended sediment in Surf and Swash zone to construct tubes that lead to colony formation, similar conditions do not persist in deeper water (14-16 feet). Low relief pilot modules were also smothered, most probably by long-shore sediment transport, and NRC report (P. 26) suggests, It is possible that sessile species that occupy hard bottom reef habitats can be smothered by sediment… planktonic larvae of both vertebrates and invertebrates may be adversely impacted, filter-feeding mechanisms may become impaired, and photosynthetic activity may decrease (NRC 1995). Juvenile and small fish subjected to high sedimentation can die from anoxia. Elevated sediment concentrations can also lead to egg abrasion and reduced ventilation rates in mollusks. Turbid conditions decrease light penetration, which can reduce primary productivity.

Although the mitigation reef is design to mimic formations found close to shore their viability and utility in depths of 14 to 16 feet is questionable at best. Further even if a mitigation reef of greater rugosity was placed adjacent to edge of existing formations, it would have to placed well in advance of the project to ensure that recruitment and survivability of encrusting organisms. Problems with the establishment of communities on the Indian River County mitigation reef suggest that it may take several years for these reefs to function as refugee and replacement habitats.

In summary, NMFS concurs with the findings and recommendations of the FWCAR.

In addition NMFS would suggest that;

- The issue of restoration of the sand budget in the Mid-reach should be addressed. In this regard it may not be necessary to place all the sand necessary to slow erosional rates directly on the beach or in the nearshore.
- That all impact areas be properly and accurately represented, areal coverage interpreted from aerial photograph misses important physical attributes of the nearshore reef and is not an accurate portrayal of what would be loss from direct and indirect burial.
- Secondary and cumulative impacts must be accounted for
- Further, avoidance and minimization could be achieved by avoiding any impacts in areas that have greater coverage of hard bottom and demonstrate a richer species diversity. This could be accomplished by increasing sand placement, in front of near shore rock formations and or by increasing fill to the south of the Mid-reach.
- If any mitigation reef is constructed, it must be constructed well in advance of the project to ensure viability, and recruitment by the appropriate assemblages of organisms at similar lifestages to those found in impacted area. This may be possible if the mitigation reef is placed directly in front of existing rock formations and exhibits similar physical attributes to the adjacent rock formations. Appropriate water depth of the reef and surrounding water temperature appear to be critical elements to recruitment and survivability of *P. Lapisdosa* in Brevard's Mid-reach.