APPENDIX B

ESSENTIAL FISH HABITAT

TYBEE ISLAND, GEORGIA
SHORE PROTECTION PROJECT
2014-2015 RENOURISHMENT

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT

JUNE 2014

This page intentionally blank.

ESSENTIAL FISH HABITAT ASSESSMENT

Tybee Island, Georgia
Shore Protection Project 2014-2015 Renourishment

1.0 INTRODUCTION

The purpose of this document is to present the findings of the Essential Fish Habitat (EFH) assessment conducted for the proposed Tybee Island Shore Protection Project as required by the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended through 1996 (Magnuson-Stevens Act). The objectives of this EFH assessment are to describe how the actions proposed by the project may affect EFH designated by the National Marine Fisheries Service (NMFS) and the South Atlantic Fisheries Management Council (SAFMC).

The EFH assessment will include a description of the proposed action, coordination history, an analysis of the direct, indirect, and cumulative effects on EFH for the managed fish species and their major food sources, and the District views regarding the effects of the proposed action.

This evaluation is conducted in accordance with Section 305(b) (2) of the Magnuson-Stevens Fishery Conservation and Management Act (As Amended Through October 11, 1996). That provision states: "Each Federal agency shall consult with the Secretary with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act." It is also done in accordance with the Interim Final Rule (par. 600.920(g)) that requires an EFH Assessment contain the following: (1) Description of the Proposed Action, (2) An Analysis of the Effects, including cumulative effects, of the action on EFH, the managed species, and associated species by life history stage, (3) The Federal agency's views regarding the effects of the action on EFH, and (4) Proposed mitigation, if applicable.

2.0 PROJECT DESCRIPTION

This authorized 3.5 mile long project was initially constructed in 1974 with a 50-year project life and periodic renourishments to occur every 7 years. The beach was last renourished in 2008 and is scheduled to be renourished again in 2015. In 2015, there will be 9 years left in the project life (i.e. Federal participation). The Savannah District, with the non-Federal sponsor’s concurrence, selected to

perform the 2015 periodic renourishment for the remaining 9 years of the 50-year project life.

Beach fill final placement will be based on physical conditions and funds available at the time of construction. Alternative bid schedules will be used to optimize the quantity of beach fill placed for the funds available. The proposed project is expected to commence by November 2015, and be completed by April 30, 2016. No construction would occur during sea turtle nesting and hatching season, 1 May – 1 October. Federal participation in the Federal project expires in 2024, 9 years after the time of the proposed construction.

The current project template design is based on project performance and erosion rates since the last renourishment project in 2008. Beach fill will primarily be placed in areas included in the previous renourishment in 2008. Figure 1 displays the proposed placement locations. These areas include the North Beach (North End Groin to Oceanview Court), Second Street area (Oceanview Court to Center Street), Middle Beach (Center Street to 11th Street), South Beach (11th Street to South End Groin), and Back River/Tybee Creek (South Tip Groin Field to Inlet Avenue). Additional fill will be placed between these areas to provide a more stable beach profile and to avoid some of the excessive losses in the 2nd Street "hot spot", a highly erosional area. Constructed beach widths on the Back River Beach vary from 30 feet to 110 feet at +11.22 feet mean lower low water (MLLW). Constructed beach widths on the Front Beach will vary from a 25 foot width berm, to a berm approximately 350 feet wide at the elevation of +11.22 MLLW. The designed Front Beach slope is 1V:25H, based on experience with previous nourishments. The Back River will have an +11.22 foot elevation MLLW and a 1V:15H slope. Figure 2 shows the proposed template slopes.

Figure 1: Proposed Template For Recommended Alternative

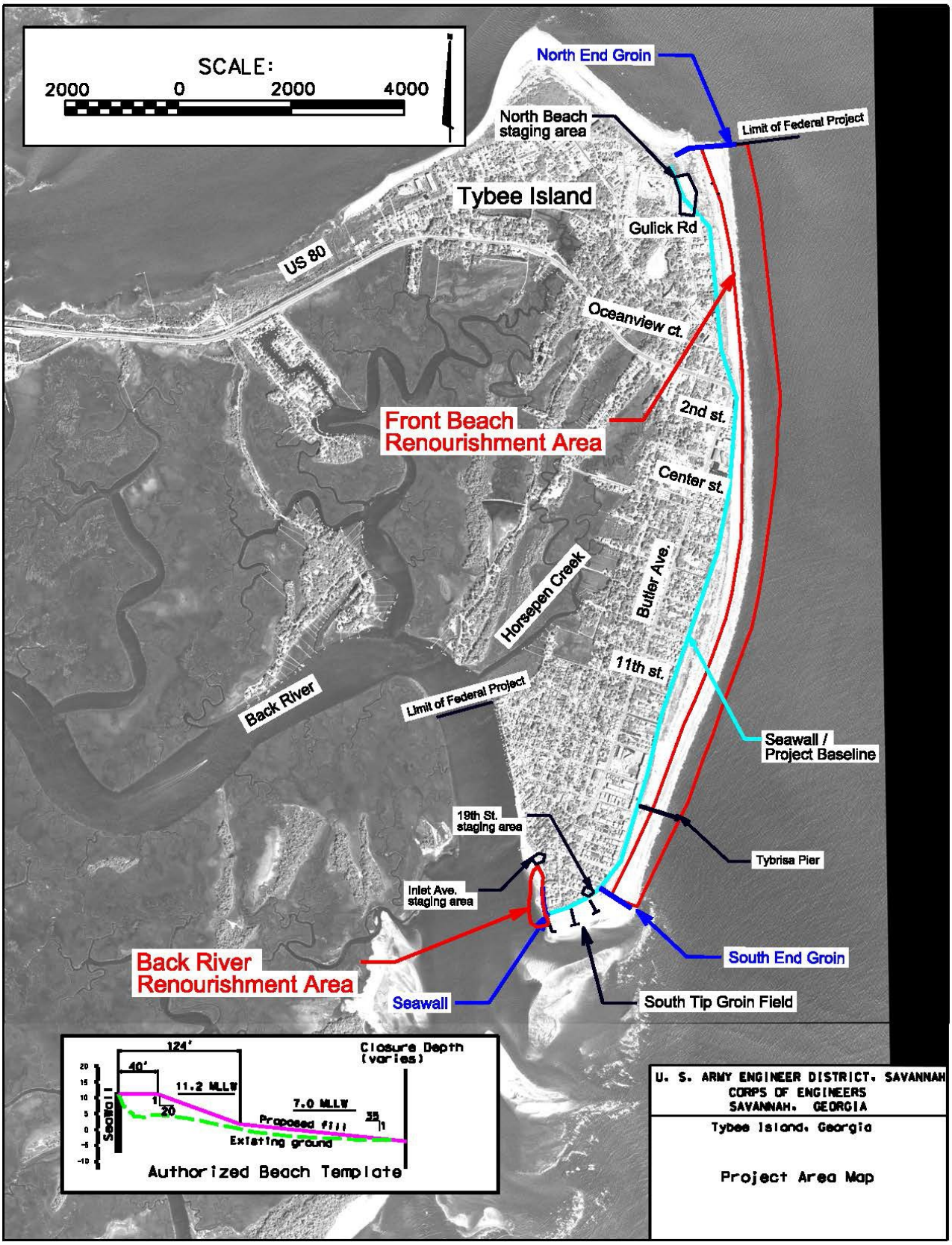
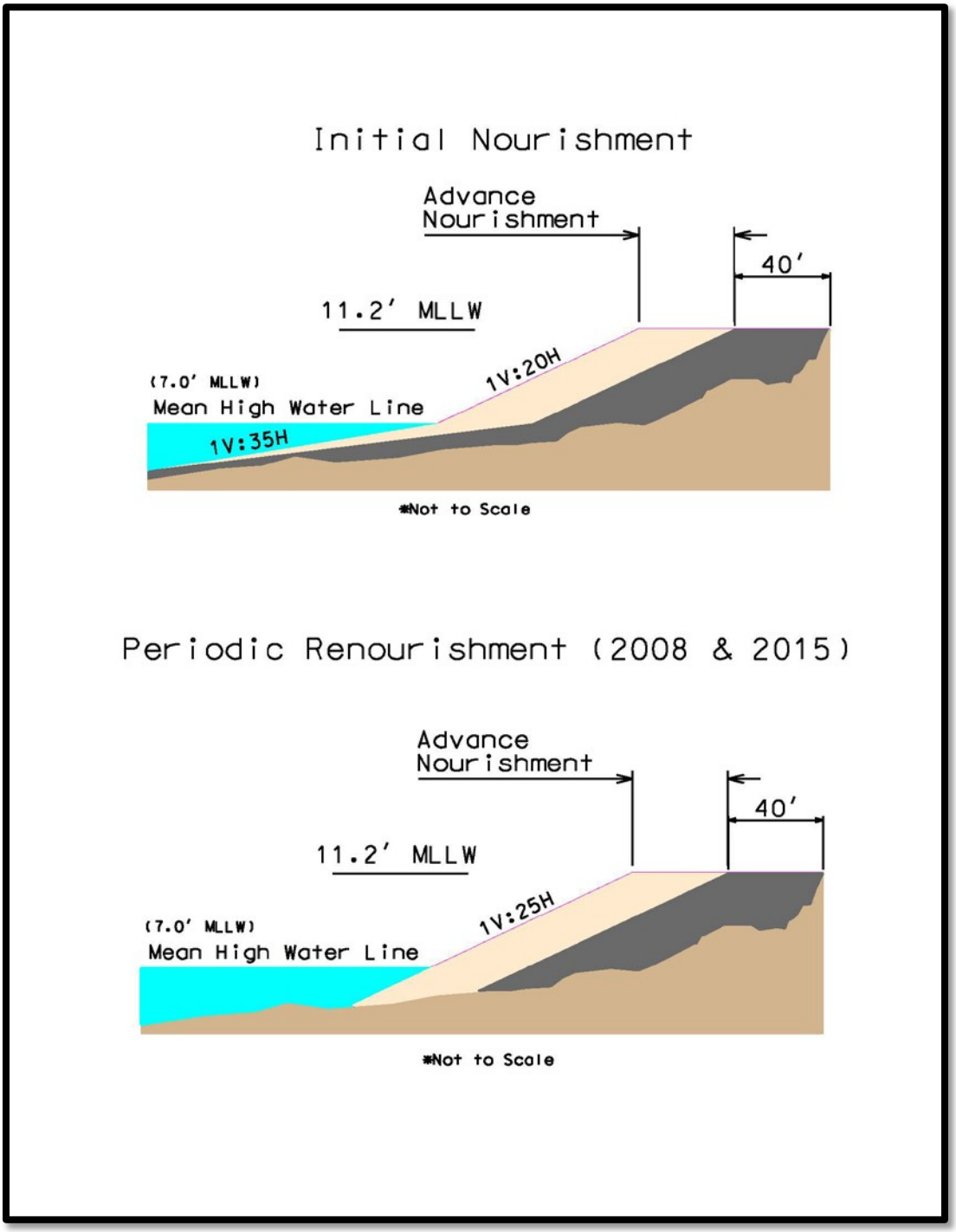


Figure 2: Proposed Slope*



***Back River Beach will have a slope of 1V:15H**

The 2015 renourishment consists of placing fill volume to restore the project plus an additional 312,000 cubic yards (c.y.) to account for potential erosion through 2024. In addition, the berm will be extended seaward up to 50 feet beyond the previously constructed template to account for erosion during the additional 2 years for a 9 year cycle. The beach template will be slightly modified to include placement of the additional 312,000 c.y. of material by extending the berm north to the terminal groin of the template. This area has been nourished during previous renourishment cycles, but not during the 2008 renourishment. Figure 3 shows the proposed fill limits and locations.

A portion of Borrow Area 4 was utilized during the 2008 renourishment and produced highly compatible beach renourishment material. Within this site not all areas were disturbed in 2008 and enough high quality material remains for use in 2015. The borrow area is approximately 4,000 feet (0.75 miles) southeast of the southernmost Federal terminal groin. Figure 4 shows Borrow Area 4 and locations of previously dredged area and area proposed for use during the 2015 project.

As proposed, the project will be constructed using a hydraulic cutterhead pipeline. A submerged pipeline will extend from the borrow site to the southerly tip of Tybee Island. Shore pipe will be progressively added to perform fill placement along the shorefront areas to be renourished. Temporary toe dikes will constructed parallel with the shore to control the hydraulic effluent and reduce turbidity. The sand will be placed in varying design templates based upon alongshore volumetric fill requirements which reflect beach conditions at the time of construction.

Figure 3: Proposed Fill Limits For 2015 Tybee Beach Renourishment

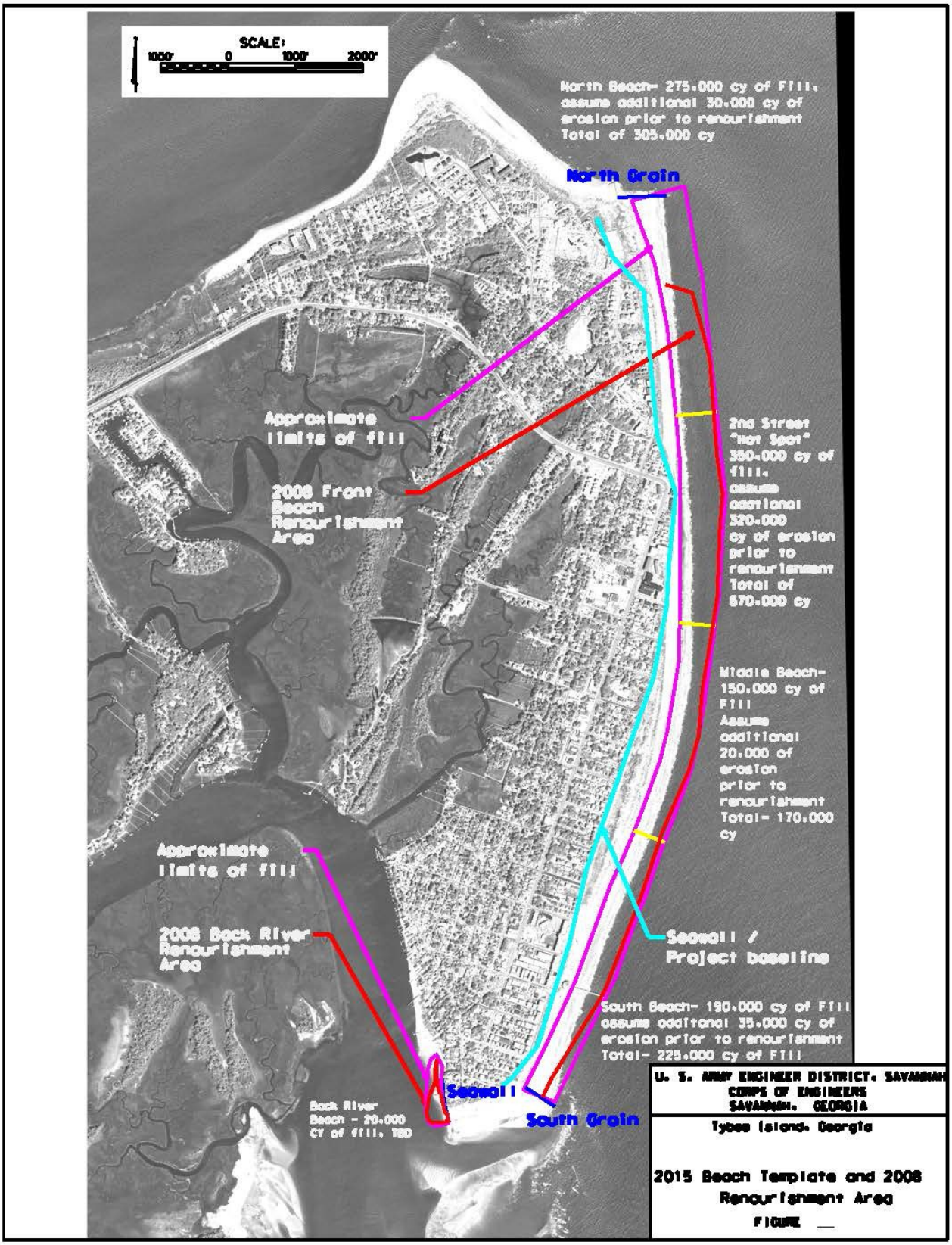
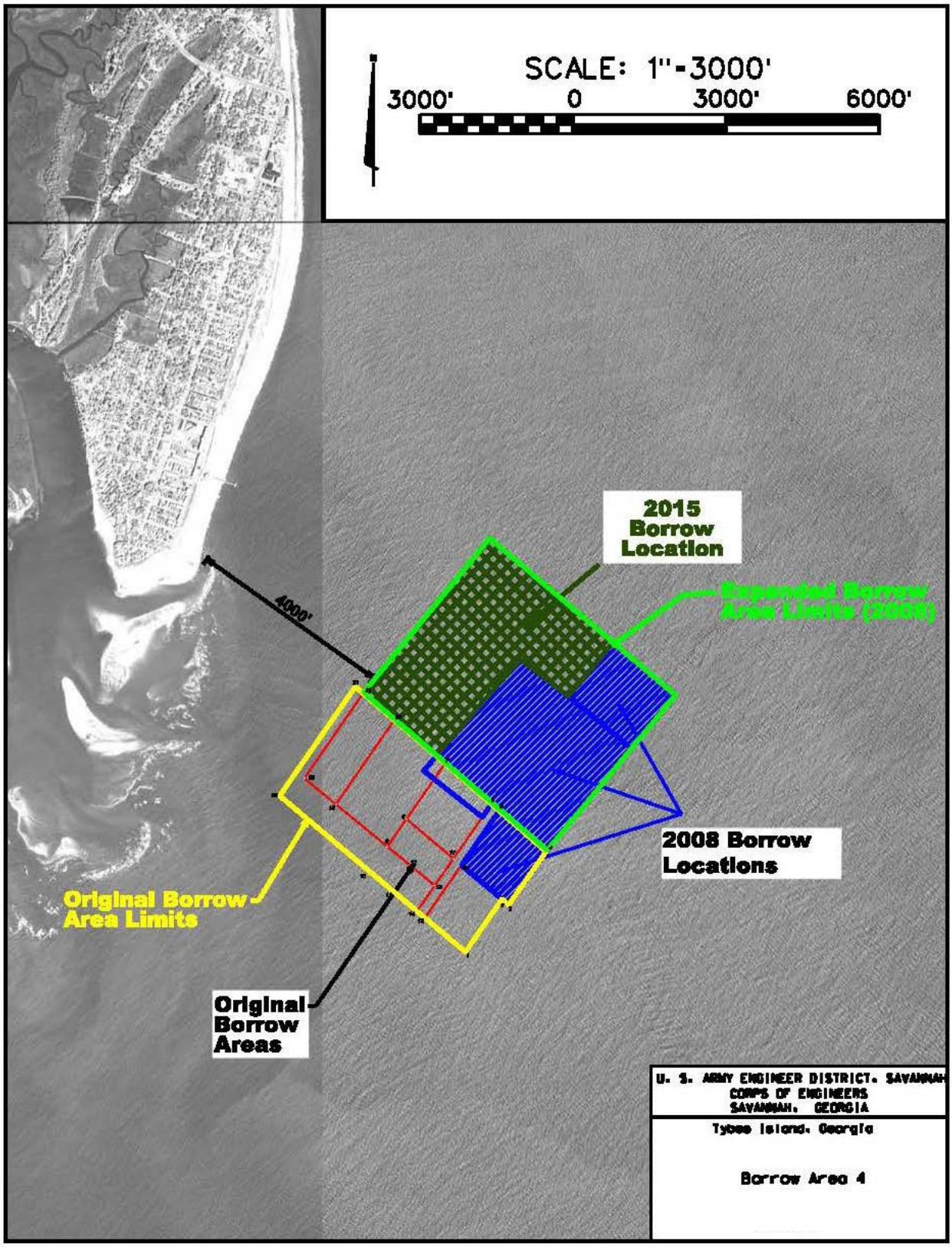


Figure 4: Proposed Borrow Area



2.1 Coordination

Savannah District initiated EFH consultation of the proposed project with the National Oceanic and Atmospheric Administration (NOAA) Fisheries Habitat Conservation Division and is received concurrence with the effects analysis and conservation recommendations found in Appendix E.

Prior Tybee Island EFH Coordination:

1995 renourishment - NMFS expressed concerns on project impacts to a) Little Tybee Island, b) potential contaminant releases associated with the use of dredged material taken from the Savannah Bar Channel, c) status of living marine resources within the borrow areas, d) impacts to beach benthic organisms, e) impacts to hard bottoms, f) impacts to larval fish and shellfish, g) and suitability of material in the borrow area and potential contaminant releases and recommended coordinating with EPA.

Corps responses a) The borrow area chosen was outside of the area that could impact Little Tybee, b) borrow area material was tested and found suitable for ocean disposal however, the material selected for beach nourishment will be tested again for contaminants to ensure suitability for beach placement, c) coordination with GA DNR indicated no concerns for existence of communities in the borrow area that could be impacted, d) similar habitat for these benthic organisms is available nearby on Little Tybee and on areas outside of the template at Tybee. Impacts are expected to be short-term as these species will likely recolonize, e) no hard bottoms exist in the area, f) recommendations by USFWS and GA DNR have been to avoid construction activities during 1 March – 1 June. No recommendations were made by NMFS for other avoidance windows, based on current knowledge no work will occur during 1 March – 1 June, g) the Section 103 report for deepening Savannah Harbor evaluated sediment samples and found them acceptable for ocean disposal. EPA concurred with the 103 evaluation.

2000 renourishment - NMFS provided the following comments- a) Sand nourishment should not occur during 15 May through 31 October, b) Cumulative impacts of beach nourishments along the southeastern Atlantic coastline should be examined, and c) Restrictive work zones should be established to protect tidal flats, vegetated dunes and wetlands.

Corps responses a) Construction would not occur during this time period, b) Hydrology evaluations and monitoring studies were conducted to determine if any cumulative effects were likely to adjacent shorelines, such as Little Tybee. No negative impacts were anticipated. c) Staging areas were designated to minimize construction traffic and protect sea dunes and other beach vegetation.

2008 renourishment – NMFS provided the following comments – a) To minimize the potential impacts to fishery resources from incompatible sediments, NMFS recommends close monitoring of sediment characteristics during sand placement and strict enforcement of the depth limitation at the borrow area, b) implementation of a biological monitoring program focused on measuring the recovery of benthic communities at both the beach and borrow areas. Post-construction monitoring should occur during the spring and fall for three years after construction is completed.

NMFS provided three conservation recommendations: 1. The borrow area shall be mined selectively to reduce the amount of silt and shell placed on the beach. A monitoring program shall be implemented to document any changes to sediment texture along the beach and to characterize, relative to reference areas, the abundance and fishery value of infauna within the fill area. The monitoring plans shall be submitted to NMFS for approval prior to construction.

2. Bathymetric surveys shall be conducted immediately after and one year after project completion to demonstrate compliance with dredging depth restrictions and to demonstrate the borrow areas are filling at rates presumed acceptable for fishery resources.

3. A monitoring program shall be implemented at the borrow area to document filling rates, nature of the material that fills the pit, and the impact the pit has on the use of the sea bottom by fish. The monitoring plans shall be submitted to NMFS for approval prior to construction.

Corps responses to comments- a) The borrow area has been investigated and results have shown sediments compatible with beach quality to a depth of -16 feet MLW. A copy of the 2007 Geotechnical Investigation which documents the results has been provided to NMFS. The percent fines content for all material to be excavated above -16 feet MLW averages less than 1%. Furthermore, we believe pre-project characterization reflects what should be expected post-project, since borrow would take place in the same general area as the last nourishment. For these reasons we do not feel a monitoring plan is warranted, b) Tybee Island Marine Science Center located on the south beach of Tybee Island, has been conducting marine science education programs since 1987. The programs have included beach seining, sediment characterization, and invertebrate studies. The center receives financial support from the Tybee Island Marine Science Foundation, the City of Tybee Island, and the Georgia Department of Natural Resources. We suggest using data collected by the Science Center to assess fishery resources in the area. We recognize the data will not be as rigorous in nature as that of research scientists however, but should provide relevant cumulative baseline data that would otherwise be difficult to assimilate.

Corps responses to conservation recommendations:

1 & 3. A monitoring program will be conducted by the South Carolina Department of Natural Resources Marine Resources Research Institute (SCDNRMRRI) on both the borrow area and beach. This monitoring program has been approved by NMFS. Results of this monitoring are included in the 2015 EA.

2. Bathymetric surveys will be conducted by the District immediately following the project and after one year to demonstrate compliance and document fill rates.

Survey's performed by SCDNR 4 months, 6 months and 12 months after the renourishment indicated the borrow area experienced an increase in silts and clays (from less than 2% pre-dredging to 12% twelve months post-dredging).

3.0 SPECIES WITH FEDERAL FISHERY MANAGEMENT PLANS

Although the SAFMC manages numerous fish stocks, only those that have Federal Fishery Management Plans (FMPs) have designated EFH. Therefore, this assessment is limited to such species. The Middle Atlantic Fishery Management Council (MAFMC) manages the following species that may inhabit the nearshore or offshore areas of Tybee Island; bluefish (*Pomatomus saltatrix*), black sea bass (*Centropristis striata)*, butterfish (*Peprilus triancanthus)*, tilefish (*Lopholatilus chamaeleonticeps)*, Summer Flounder (*Paralichthys dentatus*), and Atlantic surfclam (*spisula solidissima)*. Other fisheries under jurisdiction of the SAFMC include brown shrimp (*Penaeus aztecus*), pink shrimp (*P. duorarum*), white shrimp (*P. setiferus*), cobia (*Rachycentron canadum*), dolphin (*Coryphaena hippurus*), red snapper (*Lutjanus campechanus),* gag grouper (*Mycteroperca microlepis*), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculatus*), spot (*Leiostomus xanthurus*), and select coastal shark species. Section 6.0 describes the species and FMPs in detail.

4.0 EFH DESIGNATED BY THE SAFMC and MAFMC

Table 1 shows EFH as identified in Fishery Management Plan Amendments for the SAFMC and MAFMC, geographically defined areas of particular concern and whether or not these areas/habitats occur within the project vicinity or if areas will be impacted by project activities. Areas listed in this table were derived from SAFMC's Fishery Ecosystem Plan (SAFMC, 2009) and MAFMC's EFH source documents (www.nefsc.noaa.gov).

Table 1.
Essential Fish Habitat Areas in Georgia Waters*

Essential Fish Habitat	Potential Presence		Potential Impact	
	Near Project Area	In Project Impact Area	Dredge Operation	Beach Disposal
Tidal freshwater wetlands[1,2]	No	No	No	No
Estuarine emergent wetlands (e.g., brackish/salt marsh)[1,2]	Yes	Yes	No	No
Subtidal/intertidal non-vegetated flats[1]	Yes	Yes	Yes	Yes
Coastal inlets[4,5]	Yes	Yes	Yes	Yes
Coral reefs[2,3]	No	No	No	No
Live/hard bottom[2,3]	Yes	Yes	No	No
Unconsolidated bottom[2]	Yes	Yes	No	No
Gulf Stream[4]	No	No	No	No
Oyster reefs/shell bank[6]	Yes	Yes	No	No
Charleston Bump[8]	No	No	No	No
Sandy shoals of capes and offshore bars[7]	Yes	Yes	Yes	No
Surf zone[4]	Yes	Yes	Yes	Yes
High salinity bays, estuaries[4]	Yes	Yes	Yes	Yes

*Georgia waters lack some habitat designated as EFH by the SAFMC (e.g., submerged aquatic vegetation (SAV) and mangroves) therefore those habitats are not included in this table. Similarly, because of its nearshore location, offshore EFH such as sargassum and medium to high profile outcroppings and rocky bottom are also not included in this table.
[1]These habitats are EFH for penaeid shrimp.
[2]These habitats are EFH for snapper-grouper.
[3]These habitats are EFH for specific life stages of estuarine-dependent and nearshore snapper-grouper.
[4]These habitats are EFH for coastal migratory pelagics (e.g., Spanish mackerel and cobia).
[5]Coastal inlets are EFH-HAPCs for all snapper-grouper and EFH for coastal migratory pelagics.
[6]Oysters are EFH-HAPCs for snapper-grouper.
[7]These habitats are EFH for coastal migratory pelagics.
[8]This habitat is EFH for wreckfish and highly migratory pelagics

4.1 Estuarine Emergent Wetlands

NOAA defines estuarine emergent wetlands as initially determined by Cowardin et al. (1979) and considered to be the Federally-accepted standard: “Deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the ocean, with ocean-derived water at least occasionally diluted by freshwater runoff from the land. The upstream and landward limit is where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow. The seaward limit is (1) an imaginary line closing the mouth of a river, bay, or sound; and (2) the seaward limit of wetland emergents, shrubs, or trees when not included in (1).” Estuarine wetlands are important nursery

grounds for many fish, shellfish, and other invertebrate species. In addition to providing shelter and food wetlands also serve as erosion deterrents.

4.2. Subtidal and Intertidal non-vegetated Flats

Intertidal areas and mudflats are important dwelling habitat and feeding areas for benthic macroinvertebrates, juvenile fish species, arthropods, mollusks, and predatory organisms that feed on these species. This tidally influenced, constantly changing EFH provides feeding grounds for predators, refuge and feeding grounds for juvenile and forage fish species, and nursery grounds for estuarine dependant benthic species (SAFMC 1998). Animals that move from a pelagic larval to a benthic juvenile existence make use of these EFH flats for life stage development. These flats can provide a comparatively low energy area with tidal phases which allow species the use of shallow water habitat as well as relatively deeper water within small spatial areas. These flats also serve as refuge areas for species avoiding predators, which use the tide cycles for access to estuarine feeding grounds (SAFMC 1998).

4.3 Coastal Inlets

Coastal inlets are a connecting passage between two bodies of water. This typically refers to tidal openings in barrier islands, but can also be applied to river mouths in tidal and non-tidal environments (http://chl.erdc.usace.army.mil/glossary). These areas serve as migratory corridors for fishery resources that utilize oceanic and estuarine habitats (SAFMC, 1998). Coastal inlets are closely connected to beach stability, estuary health, exchange of nutrients, water, and sediments between estuaries and the ocean, and recreational opportunities (USACE CIRP, 2008) http://cirp.usace.army.mil/. Coastal inlets are EFH-HAPCs for all snapper-grouper and EFH for coastal migratory pelagics. In addition, the Mid-Atlantic Fishery Management Council designates coastal inlets as EFH for bluefish and the NMFS designates coastal inlets as EFH for a variety of sharks. Coastal inlets provide protection and serve as nursery grounds for fish species including blue fish, black sea bass, butterfish, summer flounder, red drum, cobia, and Spanish mackerel.

4.4 Live/Hard bottom

Grays Reef National Marine Sanctuary is one of the largest live-bottom reefs in the state. The sanctuary is located approximately 40 miles southeast of Tybee Island and is not likely to be impacted by the project. There are other patches of live and hard bottom areas scattered along the outer continental shelf near the project area however, no impacts are expected as a result of the project to these habitats.

4.5 Unconsolidated Bottom

Unconsolidated bottom is defined by USGS as all wetland and deepwater habitats with at least 25% cover of particles smaller than stones, and a vegetative cover less than 30%. Water regimes are restricted to subtidal, permanently flooded, intermittently exposed, and semi-permanently flooded. Diverse assemblages of benthic macroinvertebrates utilize these areas and serve as food sources for demersal fish species.

4.6 Oyster Reefs Shell Banks

Oyster reefs and shell banks are defined by SAFMC as being the, "natural structures found between and beneath tide lines, which are composed of oyster shell, live oysters and other organisms". This habitat is usually found adjacent to emergent marsh vegetation and provides the other three-dimensional structural relief in soft-bottom, benthic habitat (Wenner et al., 1996). Optimal salinity for *Crassostrea virginica* ranges from 12ppt to 25ppt, and in Georgia the majority of reefs are intertidal. Oyster reefs are extremely important to the aquatic ecosystem as they remove particulate matter, release inorganic and organic nutrients, stabilize sediments, provide habitat cover and serve as both indirect (i.e. house macroinvertebrates) and direct food sources for various fish species.

4. 7 Sandy Shoals of bays and Offshore Bars

Offshore bars are shore-parallel deposits of sand existing seaward of the lower low water line. Offshore bars are formed from sand migrating off and onto the beach. Sand is carried by waves during storm events or by long-shore transport. Offshore bars are subtidal and typically break up wave energy depending on their height below mean sea level. This breaking helps dissipate on-shore breaking and creates the surf zone, the choppy area between the offshore bar and the beach.

4.8 Surf Zone

These areas are zones of wave action extending from the water line (which varies with tide, surge, set-up, etc.) out to the most seaward point of the zone (breaker zone) at which waves approaching the coastline commence breaking, typically in water depths of between 5 to 10 meters. On Tybee surf breaks often occur in much shallow depths, less than 1 meter and may break onshore. Surf zones are areas of high wave energy between the beach and the low water line. This area serves as an important nursery and feeding habitat for many species of juvenile fish.

4.9 High Salinity Bays and Estuaries

Estuaries are areas where fresh water rivers and marine seas converge. Estuaries serve as EFH for many managed species and their prey, by providing habitat for spawning, breeding, feeding, and growth.

5.0 GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN

Habitat Areas of Particular Concern (HAPC) are a subset of EFH that is either rare, particularly susceptible to human-induced degradation, especially important ecologically, or located in an environmentally stressed area (SAFMC, 1998). The SAFMC is responsible for the conservation and management of many species found in Federal waters in the South Atlantic Region. The Council currently has Fishery Management Plans (FMPs) for five fisheries that may occur in the project area. These include coastal migratory pelagics, penaeid shrimp, snapper-grouper, and dolphin-wahoo, as well as coastal sharks which are managed by NMFS. Of these fisheries snapper-grouper contain species that are overfished. Both the recreational and commercial snapper-grouper fisheries are highly regulated and progress continues to be made as more species are removed from the overfished list each year. The other fisheries are expected to continue into the future at productive sustainable levels (www.safmc.net). Table 2 lists the HAPC and managed species that may occur in the project area.

Table 2.
Habitat Areas of Particular Concern potentially occurring in the Tybee Island area

Habitat Areas of Particular Concern		
Coastal Migratory Pelagics		
	Species	**EFH**
	King and Spanish mackerel, cobia	Coastal Inlets
Penaeid Shrimp		
	Shrimp (brown, white and pink)	Salt marsh, subtidal/intertidal flats,
Snapper Grouper Complex		
	Red snapper, Gag grouper,	Oyster reefs, coastal inlets, salt marsh, live/hard bottom,

		unconsolidated bottoms
Dolphin/Wahoo		
	Dolphin-Wahoo	Live/Hard bottom
Live or Hard bottom		
	Snapper-Grouper	

5.1 Coastal Migratory Pelagics

HAPC for coastal migratory pelagics include coastal inlets, surf zone, and estuaries.

Since these species are migratory it is expected some life stage of the species may be present year round in the project area HAPCs.

5.2 Penaeid Shrimp

Areas which meet the criteria for HAPC include coastal inlets, estuarine emergent wetlands which serve as nursery grounds, oyster reefs and subtidal/intertidal flats.

5.3 Snapper Grouper

The snapper grouper complex utilizes both pelagic and benthic habitats throughout their life cycles. Larvae are free swimming within the water column. During this stage they commonly feed on zooplankton. Juveniles and adults are frequently bottom dwellers that associate with hard structures with moderate to high relief. The principal fishing areas are located in live bottom and shelf-edge habitats in deeper waters. The species tend to form sizable spawning aggregations, but this might not be the case with all species.

Coastal inlets and oyster beds are considered HAPC. These areas are critical for spawning activity as well as feeding and daily movements.

5.4 Dolphin/Wahoo

In 2004 the SAFMC developed a precautionary FMP for Dolphin/Wahoo. These species are one of the highest sought in recreational fisheries. Dolphin and wahoo are offshore large, fast swimming, and short lived marine fishes. Spawning occurs nearshore in summer months. EFH and HAPC for dolphin and wahoo includes sargassum, which is not within the project area.

6.0 Federally Managed Fish Species

Ten families of fish containing 60 species are managed by the SAFMC. Other species occurring in the project area are managed by the MAFMC. Table 3 lists federally managed species with FMPs that may occur in the project area.

Table 3.
Federally Managed Species with Fishery Management Plans that may Occur in the Project Area.

Mid-Atlantic FMPs species		
Common Name	**Scientific Name**	**EFH**
Bluefish	*Pomatomus saltatrix*	Coastal inlets, estuaries
Spot	*Leiostomus xanthurus*	Coastal inlets, estuaries
Summer Flounder	*Paralichthys dentatus*	Coastal inlets, estuaries, salt marsh
Tilefish	*Lopholatilus chamaelonticeps*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars
Black Sea Bass	*Centropristis striata*	Coastal inlets, estuaries, live/hard bottoms, oyster reefs
Butterfish	*Peprilus triacanthus*	Coastal inlets, estuaries
Atlantic Surfclam	*Spisula solidissima*	Unconsolidated bottoms, offshore bars, subtidal/intertidal non-vegetated flats
Federally Implemented FMP		
Lemon shark	*Negaprion brevirostris*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars

Bull shark	*Carcharhinus leucas*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars
Dusky shark	*Carcharhinus obscures*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars
Bonnethead shark	*Sphyrna tiburo*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars, surf zone
Hammerhead shark	*Sphyrna mokarran*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars
Atlantic sharpnose shark	*Rhizoprionodron terraenovae*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars
Finetooth shark	*Aprionodon isodon*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars
Sandbar shark	*Carcharhinus plumbeus*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars
Blacktip shark	*Carcharhinus limbatus*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars
Tiger shark	*Galeocerdo cuvieri*	Coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, offshore bars

6.1 Penaeid Shrimp

Three species of penaeid shrimp (white, pink, and brown) may be found in coastal Georgia's waters throughout the year. EFH for penaeid shrimp includes estuarine emergent wetlands and subtidal or intertidal mudflats. Penaeid shrimp fishery

season may be regulated by either the SAFMC or the Georgia Department of Natural Resources (GADNR). Spawning typically occurs in the spring both nearshore and offshore.

6.2 Blue Fish

Blue fish (*Pomatomus saltatrix*) congregate near the edge of the continental shelf in October (NMFS EFH Source Document, 1999) and have coastal inlets designated as EFH. Blue fish are migratory pelagics and may be found in both the nearshore and offshore marine environment. Spawning occurs from March to May off the South Atlantic Bight.

6.3 Black Sea Bass

Black sea bass (*Centropristis striata)* are migratory and have coastal inlets designated as EFH. Spawning occurs from May to October with a peak in June (NMFS EFH Source Document, 1999) over sandy bottoms.

6.4 Butterfish

Butterfish (*Peprilus triancanthus)* are migratory pelagic. Adults and juveniles have been recorded in Georgia estuaries but prefer salinities lower than that of the open ocean (NMFS EFH Source Document, 1999) and would therefore not be expected to occur in the project area. Coastal inlets are designated EFH for butterfish.

6.5 Tilefish

Tilefish (*Lopholatilus chamaeleonticeps)* are omnivores and known to consume benthic prey as well as zooplankton, other fish, and human food waste. Tilefish utilize burrows in various forms (rocky ledges, clay hollows, or other sheltering features) and may be found off the outer continental shelf in Georgia. Offshore sandbars are designated EFH for tilefish but would not be present in the project area.

6.6 Summer Flounder

Summer Flounder (*Paralichthys dentatus*) are found in shallow estuarine waters and outer continental shelves from Canada to Florida with the most abundant between Massachusetts to North Carolina (NMFS EFH Source Document, 1999).

Designated EFH for summer flounder in Georgia includes estuaries, coastal inlets, intertidal mudflats, and estuarine emergent wetlands.

6.7 Atlantic Surfclam

Atlantic surfclam (*Spisula solidissima)* inhabits regions just beneath the surface in sand, mud or gravel from below the low-tide line to 128 m deep. EFH for the surfclam is subtidal non-vegetated flats and offshore sandbars.

6.8 Cobia

Cobia (*Rachycentron canadum*) are coastal migratory pelagic species managed by the SAFMC. EFH for these species includes coastal inlets, surf zone, and high salinity estuaries. Cobia occur worldwide in warm waters and are often found around sea buoys or other flotsam and jetsam.

6.9 King Mackerel

King mackerel (*Scomberomorus cavalla)* are coastal migratory pelagic species managed by the SAFMC. EFH for these species includes coastal inlets, surf zone, and high salinity estuaries. Young king mackerel are often found schooling with Spanish mackerel. This species is commonly sought after for food and sport in commercial and recreational fisheries.

6.10 Spanish Mackerel

Spanish mackerel (*Scomberomorus maculates)* are coastal migratory pelagic species managed by the SAFMC. EFH for these species includes coastal inlets, surf zone, and high salinity estuaries. Their life span is between five to eight years and they are often found in large schools both in deep waters and shallow estuaries. Spanish mackerel are important to commercial and recreational fisheries. The latest stock status assessment (2012) found they are not overfished (http://www.asmfc.org/species/spanish-mackerel).

6.11 Dolphin

Dolphin (*Coryphaena hippurus*) are coastal migratory pelagic species which have a provisional FMP by the SAFMC. GADNR has regulations for fishing inside state waters.

Dolphin, commonly known as mahi-mahi, is one of the most sought after sport and

food fish. EFH for dolphin includes sargassum, which is not within the project area.

6.12 Red Snapper

Red snapper (*Lutjanus campechanus*) have been historically overfished but a recovery plan has shown success in species recovery. A favorite food and sport fish populations declined from approximately 3 million to less than 1 million from 1955 to 2008 (pewenvironment.org). In 2010 the SAFMC initiated a moratorium on red snapper fishing in Florida, Georgia, South Carolina and North Carolina. The restriction was lifted in the summer of 2013 after a stock assessment found the species was out of overfished status.

Snapper grouper species utilize both benthic and pelagic habitats during their life cycle. They live in the water column and feed on zooplankton during their planktonic larval stage, while juveniles and adults are demersal and usually associate with hard structures with high relief. EFH for these species in Georgia includes estuarine emergent wetlands, estuarine scrub/shrub wetlands, unconsolidated bottom, live/hard bottom, and oyster beds. There is variation in specific life history patterns and habitat use among the snapper grouper species complex.

6.13 Gag Grouper

Gag grouper (*Mycteroperca microlepis*) is a reef fish with adults occurring in the offshore waters of Georgia. The population was overfished in the Gulf of Mexico but has recovered. The SAFMC has implemented annual catch limits and regulations to prevent overfishing in the southeast. EFH in the project area includes oyster reefs, estuarine emergent wetlands, estuarine scrub/shrub wetlands, unconsolidated bottom, and live/hard bottom.

6.14 Spot

Spot (*Leiostomus xanthurus*) are found in nearshore and offshore areas from the Gulf of Mexico to Florida. These fish are short-lived (over four years is rare and maximum life span is six) and spawn around age two to three. Spot are important both recreationally and commercially. Landings have varied greatly over the years from 30 million to 4 million (1982 to 2011). In 2011, the SAFMC approved the Omnibus Amendment for Spot, Spotted Seatrout, and Spanish Mackerel. The Amendment updates all three species plans with requirements of the Commission's ISFMP Charter. Specific to spot, the Amendment includes a management trigger to assist the Board in monitoring the status of the stock until a full coastwide stock

assessment can be completed. The first review of triggers, which are comprised of fishery-dependent and - independent data sets, occurred in 2012. While the triggers did not trip, they were extremely close. In response to the findings, the Board agreed to watch the status of the stock for an additional year to determine whether the pattern remains before initiating management action. EFH for spot in the project area includes estuaries and tidal inlets (http://www.asmfc.org/species/spot).

6.15 Coastal Sharks

Several species of sharks may be found nearshore and offshore in the project area. EFH for coastal sharks includes coastal inlets, estuaries, subtidal/intertidal non-vegetated flats, and offshore bars. No recorded shark fatality exists for Tybee Island. Sharks are regularly caught off the Tybee Island Pier. Inshore shark fishing is regulated by the GADNR and allows fishing of Hammerheads, Atlantic sharpnose, Bonnethead, and Spiny dogfish. There is a daily limit of 1 per angler on these species. Fishing is prohibited for the following shark species; Sand tiger, Sandbar, Silky, Bigeye sand tiger, Whale, Basking, White, Dusky, Bignose, Galapagos, Night, Reef, Narrowtooth, Caribbean sharpnose, Smalltail, Atlantic angel, Longfin mako, Bigeye thresher, Sharpnose sevengill, Bluntnose sixgill, and Bigeye sixgill. Sharks occurring in waters 3 to 200 miles offshore are regulated by the SAFMC (safmc.net, asmfc.org).

7.0 Effects Analysis of the Proposed Work on EFH

Potential impacts to EFH and fish species may occur as a result of project actions at the borrow area or from placement of sand on the beach and nearshore area.

Borrow area Impacts: No estuarine emergent wetlands, live hardbottoms, unconsolidated bottoms, or oyster reefs occur in the borrow area therefore no impacts to these EFH areas are expected.

Loss of material from subtidal flats and offshore bars in the borrow area will occur due to removal of material from these habitats during construction. The borrow area is approximately 213 acres and contains enough beach compatible material to harvest approximately 1,743,750 cubic yards. This action will negatively affect the subtidal flats and offshore bars by reduction in habitat available as EFH. The post-dredge infilling rate and quality and type of the material are contributing factors to the recovery of the borrow area dredged. After the 2008 nourishment SCDNR monitored fill rates and benthic communities in the borrow area. One year post-project the study found silt and clay content increased 12%, total organic matter (TOM) increased 3%, calcium carbonate did not change significantly, and sand grain size remained within the fine sand category.

The same study found total infauna benthic communities and species richness in the borrow area increased slightly one year post dredging while species evenness and diversity decreased slightly.

A change in the hydrologic regime as a consequence of altered bathymetry may result in the deposition or scour of fine sediments, which may result in a layer of sediment that differs from the existing substrate. Benthic organisms within the defined borrow area dredged for construction and periodic nourishment would be lost. However, recolonization by opportunistic species would be expected to begin soon after the dredging activity stops. Because of the opportunistic nature of the species that inhabit the soft-bottom benthic habitats, recovery would be expected to occur within 1–2 years. Rapid recovery would be expected from recolonization from the migration of benthic organisms from adjacent areas and by larval transport. SCDNR has recommended the use of ebb-tidal shoal complexes on the downdrift end of beaches in order to assist in the faster recovery of the borrow area, and one of the factors in the selection of the proposed borrow area was the potential for faster recovery and possible reuse of the site (Bergquist et al., 2009).

The surf zone would experience elevated turbidity levels from borrow area dredging. Dredging in the selected borrow area would involve mechanical disturbance of the bottom substrate and subsequent redeposition of suspended sediment and turbidity generated during dredging. Factors that are known to influence sediment spread and water column turbidity are grain size, water currents and depths. During construction, there would be elevated turbidity and suspended solids in the immediate area of sand deposition when compared to the existing non-storm conditions of the surf zone. Significant increases in turbidity are not expected to occur outside the immediate construction/maintenance area (turbidity increases of 25 nephelometric turbidity units (NTUs) or less are not considered significant). Turbid waters (increased turbidity relative to background levels but not necessarily above 25 NTUs) would hug the shore and be transported with waves either up-drift or downdrift depending on wind conditions. Because of the low percentage of silt and clay in the borrow areas (less than 10 percent), and the high shell content, turbidity impacts would not be expected to be greater than the natural increase in turbidity and suspended material that occurs during storm events. Any increases in turbidity in the borrow area during project construction and maintenance would be expected to be temporary and limited to the area surrounding the dredging. Turbidity levels would be expected to return to background levels in the surf zone when dredging ends. As a result of sediment suspension there is the potential for some change in local dissolved oxygen levels. However, if such a change were to occur it is anticipated it would be short term in nature and not appreciable.

Coastal inlets and estuaries would experience increased turbidity at various times

depending on tide, currents, winds, weather, and area where dredging was occurring.

Beachfront Impacts: Estuarine emergent wetlands are located in the surrounding project area but not directly in the area of fill placement. Some turbidity increases in wetland areas may be expected during onshore pumping but these impacts are expected to be short-term and are not expected to adversely impact wetlands. Wetlands in the vicinity include those on Little Tybee Island and Horse Pen Creek. Ongoing erosion in the area has remained constant and changes in sediment volume/composition are not expected to significantly impact wetlands as a result of beach nourishment.

Live/hardbottoms, unconsolidated bottoms, oyster reefs, and offshore bars may experience some turbidity increases and sedimentation during beachfront placement. These impacts are not expected to be significant and none of the EFH areas are present in the beachfront template proposed for nourishment.

The proposed project will place fill in areas of Tybee's intertidal non-vegetated flats burying some organisms while others more motile will likely avoid and survive the dispersal event. Impacts to intertidal areas are expected to be temporary and minor in nature. A monitoring plan may be developed to determine the success of recolonization of these areas by organisms. Although intertidal areas will experience some negative effects the habitat will increase in size due to the fill placement resulting in an overall benefit.

Impacts to coastal inlets as a result of the proposed project include elevated turbidity during construction and changing sediment compositions after renourishment. Shifts in tidal current velocities may also impact coastal inlets after construction.

During beachfront fill placement surf zone and estuarine areas will experience turbidity increases. Temporary toe dikes will be utilized in a shore parallel direction to control the hydraulic effluent and reduce turbidity.

The 2008 SCDNR study examined at impacts after the last renourishment to beachfront benthic organisms. The study examined ghost crab and bean clam densities pre and post fill placement and beach sediment characteristics. Ghost crab habitat increased significantly post project while actual densities of ghost crabs decreased post nourishment.

Oceanic nekton are active swimmers, and are distributed in the relatively shallow

oceanic zone. Any entrainment of adult fish, and other motile animals in the vicinity of the borrow area during dredging would be expected to be minor because of their ability to actively avoid the disturbed areas. Fish species are expected to leave the area temporarily during the dredging operations and return when dredging ceases (Pullen and Naqvi 1983). Impacts to the nekton community of the nearshore ocean will be temporary and minor. Beach nourishment may have negative effects on intertidal macrofauna through direct burial, increased turbidity in the surf zone, or changes in the sand grain size or beach profile. While beach nourishment may produce negative effects on intertidal macrofauna, they would be localized in the vicinity of the nourishment operation. Construction and subsequent nourishments will occur during the winter months when possible. Because of this, beach nourishment would therefore be completed before the onshore recruitment of most surf zone fishes and invertebrate species. To assure compatibility of nourishment material with native sediment characteristics and minimize impacts to benthic invertebrates from the placement of incompatible sediment, all sediment identified for use for this project has gone through compatibility analysis to assure compatibility with the native sediment. In summary, only temporary effects on intertidal macrofauna in the immediate vicinity of the beach nourishment project would be expected as a result of discharges of nourishment material on the beach.

7.1 Species Impacts

7.1.1 Penaeid Shrimp

Penaeid shrimp are the most valuable fishery in the southeastern United States (www.dnr.sc.gov). The project is not likely to affect fishery landings or result in impacts to the species abundance due to the short duration and nature of construction (in water hydraulic cutterhead suction dredge and on near/onshore placement). Penaeid shrimp food supplies are not expected to be adversely impacted due to the availability of other suitable foraging habitats nearby.

Adult white shrimp (*Litopenaeus setiferus*) may be affected by increased turbidity, borrow area suction, and burial nearshore. Spawning season is outside of the proposed construction timeline therefore gravid adults are not likely to be impacted.

Brown shrimp (*Farfantepenaeus aztecus*) adults spawn primarily offshore in the fall and spring but occasionally brown shrimp have been found to spawn in winter. Juvenile shrimp congregate in estuaries finding food and refuge in mudflats, saltmarsh, and sandbars. Species impacts are the same as those for white shrimp and include turbidity impacts, suction at the borrow area and burial during placement.

Pink shrimp (*Farfantepenaeus duorarum*) are the least abundant of the three species occurring Georgia waters. Pink shrimp prefer seagrass beds which are not found in the project area therefore only minimal impacts to this species are likely.

Brown and white shrimp (juvenile and adult) utilize the nearshore areas of Georgia's coastal waters for feeding but are not expected to be adversely affected due to the availability of other suitable habitat nearby.

7.1.2 Blue Fish

Impacts to Blue fish and other migratory pelagics are not expected. These species are highly motile and would be expected to move out of the area of suction or dispersal. Short term displacement may occur during construction but this species is likely to be found offshore beyond the borrow area in warmer waters closer to the gulf stream. Blue fish migrate to the South Atlantic Bight as water temperatures drop during the fall and winter months. Spawning occurs offshore during the spring through summer (http://www.asmfc.org/species/bluefish). Adult bluefish are opportunistic feeders and feed on whatever is available in their vicinity. Juveniles feed largely on copepods and small fish.

7.1.3 Black Sea Bass

Black sea bass are migratory pelagic and are likely to be found in Georgia's winter months offshore at depths >240 feet (http://www.asmfc.org/species/black-sea-bass). Adult black sea bass are not expected to be present in either the borrow area (less than 20 feet deep) or nearshore during construction. Juvenile species present nearshore may be able to move out of the construction area therefore only minor impacts are to be expected. Juveniles prey on small benthic crustaceans, polychaetes, and small fish.

7.1.4 Butterfish

Butterfish, another migratory pelagic species, have occasionally been collected on ocean beaches and in the lower and middle reaches of estuaries around Sapelo Island, approximately 40 miles southwest of Tybee Island. Spawning occurs offshore when water temperatures are above 15°C. Project impacts are expected to be minor and most likely to temporarily affect food supply by burial or removal from the borrow area (NMFS EFH Source Document, 1999).

7.1.5 Tilefish

Only minor impacts to tilefish are expected as no EFH occurs in the project area (offshore sandbars). Impacts to transitory tilefish would be increased turbidity and temporary reduced prey sources in the borrow area.

7.1.6 Summer Flounder

Summer Flounder spawn offshore in the late fall. Juveniles move inshore after spawning and spend most of their time burrowing in soft bottom sediments which serve as protection and provide a cover for ambushing prey sources. Adult summer flounder are likely to be found offshore during winter months beyond the borrow area (NMFS EFH Source Document, 1999). Juvenile fish nearshore would likely move out of the borrow area if present thereby avoiding impacts. Some impacts from turbidity increases during shoreline placement may affect a few fish however the majority of the impacts will result from a change in nearshore bottom composition. Several areas nearshore have filled in with fines, which flounder may find attractive, and will now be filled with beach quality sands, creating a less attractive substrate.

7.1.7 Atlantic Surfclam

Atlantic surfclams in the South Atlantic Bight spawn during spring and early summer. Juveniles are transported by the currents and settle on nearshore non-vegetated flats or offshore sandbars. Highest concentrations of surfclams are in waters greater than 20 feet in depth; however surfclams may survive and settle in nearshore estuaries or beach fronts (NMFS EFH Source Document, 1999). During the 2008 renourishment a survey of the borrow area was conducted and no surfclams were recorded, however two individuals were collected at a reference site nearby (Bergquist et. al, 2010). If surfclams are present in the project area they may be impacted by borrow activities (suction, sediment disturbance and settlement) or placement, causing increased turbidity and possible suffocation. Since surfclams are not expected to occur in significant numbers in the area only minor impacts are expected.

7.1.8 Cobia

No impacts to Cobia are expected. Cobia are migratory pelagics and spawn in the summer months. This species would be expected to move out of any area where construction activities were occurring (safmc.net).

7.1.9 King Mackerel

King mackerel are also migratory pelagics spawning from spring to late fall. King mackerel are not likely to be found in water below 20°C (safmc.net). No impacts to this species are expected since water temperatures would be below King mackerel preferences and the species would be expected to move out of construction activities areas if present.

7.1.10 Spanish Mackerel

No impacts to Spanish mackerel are expected as this species is another coastal migratory pelagic and would be expected to move out of construction activities. Spanish mackerel winter off Florida and would not be expected to be in the project area. Spawning occurs in the spring to early fall (http://www.asmfc.org/species/spanish-mackerel).

7.1.11 Dolphin

No impacts to Dolphin are expected because these fish are coastal migratory pelagics and capable of swimming out of the impact areas.

7.1.12 Red Snapper

Red snapper spawn from summer to fall. Adults are typically found offshore while juveniles may be found nearshore in sandy or non-vegetated mud flat habitats (safmc.net). Minor impacts to this species may occur from elevated turbidity. It is expected Red snapper would move out of the construction areas.

7.1.13 Gag Grouper

No impacts to adult Gag grouper are expected as this species typically occurs offshore, outside of the impact areas. Spawning occurs in late winter offshore. Juveniles utilize estuaries and may experience minor negative impacts resulting from increased turbidity nearshore (safmc.net).

7.1.14 Spot

Spot are expected to be found in the project area but impacts are expected to be minor as it is anticipated the species would avoid construction areas. Spawning

occurs offshore in fall to early spring (http://www.asmfc.org/species/spot).

7.1.15 Coastal Sharks

No adverse impacts to coastal sharks are expected as these fish are capable of avoiding construction areas. A small portion of available foraging area will be negatively impacted for a short duration but due to the availability and abundance of other foraging areas nearby this impact is expected to be minor.

The potential for adverse impacts to fish with EFH or management plans designated in the project area is likely to differ from species to species, depending upon life history, habitat use, distribution, abundance and feeding behaviors. However, it is anticipated that short term impacts to older lifestages of fish will be limited to temporary displacement during borrow area dredging and sand placement. There may be some entrainment of eggs and early larval stages of fish species during the dredging process. However, it is anticipated that this displacement will not be significant because pelagic larvae and eggs will continue to be carried through the project area with prevailing tides, currents, and wave action.

7.2 PREVIOUS MONITORING

As part of the 2008 renourishment NMFS recommended monitoring both the fill and borrow area to document changes relative to a control area and assess long-term recovery. Savannah District coordinated this monitoring with South Carolina Department of Natural Resources and a Before After Control Impact (BACI) monitoring program was conducted to address concerns relayed by NMFS on the lack of bathymetric and benthic data in Georgia where beach renourishment occurs. Results of the monitoring and recommendations are summarized below and discussed in the EA under section 4.18.

Borrow area monitoring:

- The content of fine silts and clays as well as finer silts increased in the borrow area relative to an undredged reference site and remained elevated one year after.

- Infaunal communities changed significantly following dredging but appeared to be a product of seasonal changes more so than dredging.

- Biological communities changed the greatest during the six and twelve months post-dredging period, rather than immediately after dredging in the borrow area.

- The borrow area amphipod community, which normally responds quickly in a negative manner to dredging, exhibited very little change immediately after dredging and decreased in the six and twelve month survey.

- Polychaete worm populations increased in the borrow area (an opportunistic species).

Recommendations:

- Minimize the depth of borrow pits located within the potential influence of major tidal inlets or rivers such as the Savannah River. This may prevent the area from filling in with fines.

- Perform hydrologic and sediment transport modeling studies prior to borrow pit dredging to improve the likelihood of sustainable use of borrow areas.

- Continue monitoring the benthic environment within the borrow area and perform thorough vibracore surveys of this borrow area if it is to be reused in future nourishment projects.

- Improve pre-construction project coordination so that borrow area monitoring is performed at more than one time prior to dredging.

- Improve record-keeping of project statistics to improve information compatibility and future management decisions.

Beach monitoring:

- Beach sediment characteristics changed very little after renourishment, supporting the findings that the borrow area sediments used were of a good match to existing beach sediments.

- Little evidence was found that ghost crab populations decreased significantly in the nourished segments compared to un-nourished reference sites.

- Data suggested that adult ghost crabs avoided the areas of active renourishment and successfully recolonized the affected beach system afterward.

- A decline in juvenile ghost crabs was evident across the entire beach system though adult populations remained relatively stable.

- The small size of Tybee Island made it difficult to distinguish significant

changes in ghost crab populations.

- Bean clam densities declined during renourishment.
- There was low recruitment of juvenile clams to the renourished areas during the post-nourishment monitoring period.
- During 2010 a mass mortality of bean clams and other infaunal bivalves occurred at beaches along South Carolina and Georgia. However, the study could not definitively attribute the decline to the beach renourishment.
- Declines in the bean clams may also have affected ghost crab recruitment as the clam is one of the major prey sources.

Recommendations:

- Maintain the careful matching of borrow sediments to the receiving beach.
- Focus future environmental monitoring efforts on addressing the consequences of the sediment and/or biological changes detected in this and similar monitoring programs.
- Incorporate an external control/reference site into future monitoring projects on Tybee Island.

8.0 THE DISTRICT'S VIEWS ON THE EFFECT OF THE PROPOSED WORK ON EFH

Impacts to EFH and HAPC include coastal inlets, estuaries, intertidal non-vegetated flats, coastal inlets, unconsolidated bottoms, offshore bars, and the surf zone. The use of best management practices (order of construction, shore parallel temporary toe dikes) should limit turbidity impacts, which would be most likely to displace fish species utilizing the area. Recolonization of both the beach and borrow area by benthic organisms is expected within 6 months to a year. Overall, the District expects impacts to EFH and HAPC to be short term and minor and does not anticipate significant effects on managed species.

8.1 PROPOSED MITIGATION

Several of the recommendations for the SCDNR monitoring have been incorporated in this proposed renourishment. Borrow area monitoring was

conducted to ensure enough beach quality sand is available, pre-construction coordination has been conducted in a timely manner, and borrow area sediments have been analyzed to ensure compatibility with existing beach sediments. Other recommendations were discussed and may be incorporated/analyzed in future studies.

Results of the last renourishment monitoring did not show significant adverse impacts to benthic organisms on the beach. Sediment compatibility was excellent enabling continued usage of the beach for listed or managed species. No negative impacts to piping plovers or sea turtles were detected after the 2008 renourishment. Borrow area monitoring results showed the area filled in with finer grained sands, silts, and clays. This was anticipated based on past surveys; however there is still adequate material available for this proposed nourishment. The study also showed evidence of recolonization in the borrow area by polychaetes and a decrease in amphipods and other crustaceans. This was also anticipated since polychaetes are an opportunistic species. Based on the time of year construction is scheduled, the short duration, the use of a mechanical hydraulic cutterhead dredge, and the protective measures in place (watch plans, BATES conservation recommendations) the Savannah District has identified no need for mitigation. The District is planning to fund another study similar to the one in 2008 conducted by SCDNRMRRI to analyze the effects of renourishment on benthos in the borrow area and surf zone.

9.0 REFERENCES

Bergquist, Derk C., Stacie E. Crowe and Martin Levisen. 2009. Change and recovery of physical and biological characteristics of the borrow area impacted by the 2007 Folly Beach emergency renourishment project. Final Report submitted to USACE, Charleston District. SC Department of Natural Resources, Marine Resources Division. Technical Report Number 104.

Bergquist, Derk C., Stacie E. Crowe and Martin Levisen. 2010. The 2008 Tybee Island Renourishment Project: Physical and Biological Responses of the Borrow Area Habitat to Dredging. Final Report submitted to USACE, Savannah District. SC Department of Natural Resources, Marine Resources Division.

Bergquist, Derk C., Stacie E. Crowe and Martin Levisen. 2010. The 2008 Tybee Island Renourishment Project: Responses of Sediment Composition and Dominant Macroinvertebrates to Nourishment. Final Report submitted to USACE, Savannah District. SC Department of Natural Resources, Marine Resources Division.

Charles A. Barans & Bruce W. Stender (1993) Trends in Tilefish Distribution and Relative Abundance off South Carolina and Georgia, Transactions of the American Fisheries Society, 122:2, 165-178.

EFH Guidance (Essential Fish Habitat: New Marine Fish Habitat Conservation mandate for Federal Agencies, National Marine Fisheries Service, Habitat Conservation Division, Southeast Regional Office, St. Petersburg, FL, February 1999).

Final Habitat Plan. (Final Habitat Plan for the South Atlantic Region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council, Prepared by the: South Atlantic Fishery Management Council, October 1998, revised 2009).

Interim Final Rule. 50 CFR Part 600. Magnuson-Stevens Act Provisions; Essential Fish Habitat (EFH); Interim Final Rule; Effective on January 20, 1998.

Limited Re-evaluation Report Tybee Island, Georgia 2008 Renourishment. USACE August 2005 (Revised December 2005).

Low, R.A., G.F. Ulrich, and F. Blum. 1983. Tilefish off South Carolina and Georgia. U.S. National Marine Fisheries. U.S. National Marine Fisheries Service Marine Fisheries Review 45(4-6): 16-26.

Pullen, E.J. and Naqvi, S.M. 1983. Biological impacts on beach replenishment and borrowing. Shore and Beach. April 1983.

Skidaway Institute of Oceanography, October 1992. Physical and chemical analysis and bioassay of sediments in the Savannah River entrance channel. Prepared for the U.S. Army Corps of Engineers, Savannah District.

Supplemental Environmental Assessment Tybee Island Beach Renourishment Project. Prepared by: Coastal Eco-Group Inc. Fort Lauderdale, FL January 2008.

U.S. Army Corps of Engineers (USACE). 2008. Final Environmental Assessment Tybee Island, Georgia Shore Protection Project, 2008 Renourishment. Savannah/Mobile District.

U.S. Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS). 1995. Endangered Species Act, Section 7 Consultation with U.S. Army Corps of Engineers, South Atlantic Division. Biological Opinion on Hopper dredging of channels and beach nourishment activities in the Southeastern United States from North Carolina through Florida East Coast.

U.S. Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS). 2012. 77 FR 5880, Rules and Regulations, (DOC), 50 CFR Parts 223 and 224, RIN 0648-XJ00 [Docket No. 100903414-1762-02], Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Population Segments of Atlantic Sturgeon in the Northeast Region, Part II, ACTION: Final rule.

Wenner, Elizabeth. 2004. State of South Carolina's Coastal Resources, Penaeid Shrimp. South Carolina Department of Natural Resources, Columbia, SC.

Wenner, Elizabeth, H. Randall Beatty and Loren Coen. 1996. A method for quantitatively sampling nekton on intertidal oyster reefs. Journal of Shellfish Research 15(3): 769-775.