Final Feasibility Report
and
Environmental Impact Statement

SURF CITY AND NORTH TOPSAIL BEACH, NORTH CAROLINA

Coastal Storm Damage Reduction Project

Appendix I

Biological Assessment

FINAL
BIOLOGICAL ASSESSMENT

Surf City and North Topsail Beach
Pender and Onslow Counties, North Carolina
Coastal Storm Damage Reduction Project

1.00 PROPOSED PROJECT

The tentatively selected National Economic Development (NED) Plan, consists of a sand dune constructed to an elevation of 15 feet above the National Geodetic Vertical Datum (NGVD), fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD. This plan is identified among the other alternatives as "Plan 1550". The berm and dune project extends along a reach of 52,150 feet. On the north end, the project will adjoin an adjacent non-Federal beachfill project for North Topsail Beach. At the south end, a 2,000-foot long, berm-only transition section would extend from the town boundary along the Topsail Beach shoreline. If the Federal project for Topsail Beach is constructed first, then the transition is not needed. All the proposed dredging will occur within the Atlantic Ocean in offshore borrow areas located approximately 1-6 miles offshore.

2.00 NATIONAL MARINE FISHERIES SERVICE (NMFS): SECTION 7 CONSULTATION HISTORY

Prior to 1991, in accordance with Section 7 requirements under the Endangered Species Act (ESA), each US Army Corps of Engineers (USACE) district within the Corps' South Atlantic Division (SAD) prepared individual project specific biological assessments for dredging activities in the South Atlantic and received subsequent individual biological opinions from the National Marine Fisheries Service (NMFS). Beginning in 1991, NMFS moved away from individual consultations for Corps dredging activities with the development of the 1991 South Atlantic Regional Biological Opinion (SARBO) for dredging of channels in the Southeastern United States from North Carolina through Cape Canaveral, Florida. In order to assess the regional implications of USACE dredging actions, the NMFS extended the use of a Regional Biological Opinion (RBO) in subsequent 1995 and 1997 SARBO consultations. To date, SAD has been implementing its dredging program under the 1997 SARBO. However, since the 1997 consultation, several re-initiation triggers have been met, such as: (1) modification of the proposed activity, (2) listing of a new species and/or critical habitat, (3) the inclusion of Puerto Rico and the U.S. Virgin Islands which had been excluded from previous opinions and (4) the current status of Section 10(a)(1)(A) scientific research permits. Therefore, on April 30, 2007 SAD sent a letter to NMFS formally requesting re-initiation of consultation for dredging activities and other associated actions in the South Atlantic under Section 7 of the ESA.

On 12 September 2008, SAD provided NMFS with the Corps' South Atlantic Regional Biological Assessment (SARBA) for federal, federally permitted, or federally sponsored (funded or partially funded) dredging activities (i.e. hopper, cutterhead, mechanical, bed leveling, and side cast) in the coastal waters, navigation channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and sand mining areas in the South Atlantic Ocean (including OCS sand resources under Minerals Management Service (MMS) jurisdiction) from the North Carolina/Virginia Border through and including Key West, Florida and the Islands of Puerto Rico and the US Virgin Islands (USVI). Dredging methods and other associated actions considered under this assessment include hydraulic dredges (i.e. pipeline and hopper), mechanical dredges, bed leveling, transportation methodology (i.e. hopper, tugs/scows, and barges), and relocation trawling. Federally threatened, endangered, or candidate species considered under this assessment include: six species of marine turtles (leatherback, loggerhead, Kemp's ridley, hawksbill, green, and olive ridley sea turtles), Acroporid corals (staghorn and elkhorn), three large whale species (North Atlantic right whale (NARW), humpback whale, and sperm whale), Johnson's seagrass, and three anadromous or marine fish species (shortnose sturgeon, Atlantic sturgeon, and smalltooth sawfish). Of the species covered under the SARBA, the following are found within the Surf City and North Topsail Beach proposed project area: five species of sea turtles (loggerhead, green, Kemp's ridley, hawksbill, and leatherback), three large whale species (NARW, humpback whale, and sperm whale), and shortnose sturgeon.

In May 2007, during a SARBA scoping meeting at the NMFS Southeast Regional Office in St. Pete, Fl, Corps and NMFS representatives agreed that all dredging activities in the South Atlantic would continue to work under the 1997 SARBO until the new SARBO was developed and finalized. For the purposes of this assessment, all dredging actions will work under the Reasonable and Prudent Measures (RPM's), Terms and Conditions (T&C's), and Incidental Take Statement (ITS) of the 1997 SARBO until a superseding SARBO is completed. Upon completion of the new SARBO by NMFS, all new RPM's, T&C's, and ITS will be adhered to as a component of this project. For those species present within the proposed project vicinity of the Surf City and North Topsail Beach (SCNTB) coastal storm damage reduction project that have already been addressed in the Corps' 12 September 2008 SARBA, an additional species life history analysis and project impact evaluation will not be provided in the ensuing text, but rather reference to the existing NMFS consultation will be made.

In summary, based on a detailed evaluation provided in the 12 September 2008 SARBA of the effects of the proposed action on sea turtle, large whale, and sturgeon species found within the SCNTB project area, Table 1 provides the effect determinations for hopper dredging and associated activities.

Table 1. Effect determination for hopper dredging and associated activities for sea turtle, large whale, and sturgeon species found within the proposed SCNTB project area (No Effect (NE – green); May Affect Not Likely to Adversely Affect (MANLA – orange); May Affect Likely to Adversely Affect (MALAA – red); and Not Likely to Adversely Modify (NLAM – yellow/orange)). (Reference: *USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE, Wilmington District. Submitted to NMFS on 12 September 2008.)*

Proposed Activity	**Effect Determination**									
	Sea Turtle					**Large Whales**			**Shortnose Sturgeon**	**Smalltooth Sawfish**
	Leatherback	***Loggerhead***	***Green***	***Kemp's Ridley***	***Hawksbill***	***NARW***	***Humpback***	***Sperm***		
Hydraulic Hopper	NE	MALAA	MALAA	MALAA	MALAA	NE	NE	NE	MALAA	NE
Bed Leveling	NE	MANLAA	MANLAA	MANLAA	MANLAA	NE	NE	NE	NE	NE
Transport - Hopper, Tug/Scow, Barge	NE	NE	NE	NE	NE	MANLAA	MANLAA	MANLAA	NE	NE
Trawling	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA				MALAA	NE
Tissue Sampling	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA					
Tagging	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA					
Dredge Lighting	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA					
Critical Habitat	NLAM		NLAM		NLAM	NLAM				

2.00 SPECIES CONSIDERED UNDER THIS ASSESSMENT

Updated lists of endangered and threatened (T&E) species for the project area (Pender and Onslow Counties, NC) were obtained from the NMFS (Southeast Regional Office, St. Petersburg, FL) (http://sero.nmfs.noaa.gov/pr/pdf/North%20Carolina.pdf) and the USFWS (Field Office, Raleigh, NC) (http://www.fws.gov/raleigh/es_tes.html) websites. These lists were combined to develop the following composite list of T&E species that could be present in the area based upon their geographic range. However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance and migratory habits, and other factors.

Table 2. Threatened and Endangered Species Potentially Present in Pender and Onslow Counties, NC.

Species Common Names	Scientific Name	Federal Status
Mammals		
West Indian Manatee	*Trichechus manatus*	Endangered
North Atlantic Right whale	*Eubaleana glacialis*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Finback whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Blue Whale	*Balaenoptera musculus*	Endangered
Birds		
Piping Plover	*Charadrius melodus*	Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Reptiles		
American alligator	*Alligator mississippiensis*	T (S/A)
Green sea turtle	*Chelonia mydas*	Threatened[1]
Hawksbill turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Fish		
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Smalltooth sawfish	*Pristis pectinata*	Endangered
Vascular Plant		
Golden sedge	*Carex lutea*	Endangered
Chaffseed	*Schwalbea Americana*	Endangered
Cooley's meadowrue	*Thalictrum cooleyi*	Endangered
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	Endangered
Seabeach amaranth	*Amaranthus pumilus*	Threatened

Status	Definition
Endangered	A taxon "in danger of extinction throughout all or a significant portion of its range."
Threatened	A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

T (S/A)	Threatened due to similarity of appearance (e.g., American alligator)--a species that is threatened due to similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation.

[1]Green turtles are listed as threatened, except for breeding populations in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

3.00 ASSESSMENT OF IMPACTS TO LISTED THREATENED AND ENDANGERED SPECIES

3.01 General Impacts

Dredging and placement of beach quality sand have the potential to affect animals and plants in a variety of ways. The potential for adverse impacts may result from actions of the dredging equipment (i.e. suction, sediment removal, hydraulic pumping of water and sediment); physical contact with dredging equipment and vessels; physical barriers imposed by the presence of dredging equipment (i.e. pipelines); and placement of dredged material on the beach within the proposed construction template (i.e. covering, suffocation). Although beach placement of material, and associated construction operations (i.e. operation of heavy equipment, pipeline route, etc.), may adversely affect some species and their habitat, the resultant constructed beach profile also promotes restoration of important habitat that has been lost or degraded as a result of erosion. Potential impacts vary according to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that could be affected, and the nature of the interaction of a particular species with the dredging activities.

Any potential impacts on federally listed threatened and endangered species would be limited to those species that occur in habitats provided by the project area. Therefore, the proposed work will not affect any listed species, which generally reside in freshwater, forested habitats, or savannas, including the American alligator, red-cockaded woodpecker, golden sedge, chaffseed, Cooley's meadowrue, and rough-leafed loosestrife. Federally listed species which could be present in the project area during the proposed action are the blue whale, finback whale, humpback whale, NARW, sei whale, sperm whale, West Indian manatee, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, shortnose sturgeon, seabeach amaranth, and piping plover.

Dredging methods and placement of beach quality sand associated with the proposed action are similar to current maintenance dredging methods and existing beach nourishment projects. These methods have been addressed in a number of previous environmental documents, including biological assessments and biological opinions rendered regarding endangered and threatened species. The accounts, which follow, will summarize this information as it applies to the proposed action.

3.02 Species Accounts

3.02.1 American Alligator, Red-cockaded Woodpecker, Golden Sedge, Chaffseed, Cooley's Meadowrue, and Rough-leaved Loosestrife.

These are all terrestrial, freshwater, woodland, or savanna species. Since this habitat type is not present in the areas to be affected by the proposed action, these species are unlikely to occur.

Effect Determination. It has been determined that the proposed action is not likely to adversely affect any of these species or their habitat.

3.02.2 Blue Whale, Finback Whale, Humpback Whale, North Atlantic Right Whale (NARW), Sei Whale, and Sperm Whale

a. Status. Endangered

b. Occurrence in Immediate Project Vicinity. These whale species all occur infrequently in the ocean off the coast of North Carolina. Of these, only the NARW and the humpback whale routinely come close enough inshore to encounter the project area. Humpback whales were listed as "endangered" throughout their range on June 2, 1970 under the Endangered Species Act and are considered "depleted" under the Marine Mammal Protection Act. Humpbacks are often found in protected waters over shallow banks and shelf waters for breeding and feeding. They migrate toward the poles in summer and toward the tropics in winter and are in the vicinity of the North Carolina coast during seasonal migrations, especially between December and April. Since 1991, humpback whales have been seen in nearshore waters of North Carolina with peak abundance in January through March (NMFS, 2003). In the Western North Atlantic, humpback feeding grounds encompass the eastern coast of the United States, the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland. Major prey species include small schooling fishes (herring, sand lance, capelin, mackerel, small Pollock, and haddock) and large zooplankton, mainly krill (up to 1.5 tons per day) (http://www.nmfs.noaa.gov). Based on an increased number of sightings and stranding data, the Chesapeake and Delaware Bays and the U.S. mid-Atlantic and southeastern states, particularly along Virginia and North Carolina coasts, have become increasingly important habitat for juvenile humpback whales (Wiley *et al*., 1995).

There are 6 major habitats or congregation areas for the western NARW; these are the coastal waters of the southeastern United States, the Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf. However, the frequency with which NARWs occur in offshore waters in the southeastern U.S. remains unclear (NMFS, 2003). While it usually winters in the waters between Georgia and Florida, the NARW can, on occasion, be found in the waters off North Carolina. NARWs swim very close to the shoreline and are often noted only a few hundred meters offshore (Schmidly, 1981). NARWs have been documented along the North Carolina coast, as close as 250 meters from the beach, between December and April with sightings being most common from mid to late March (Dr. Frank J. Schwartz, personal communication). Sighting data provided by the NARW Program of the New England Aquarium indicates that 93 percent of all North Carolina sightings between 1976 and 1992 occurred between mid-October and mid-April (Slay, 1993). The occurrence of NARWs in the State's waters is usually associated with spring or fall migrations. Due to their occurrence in the nearshore waters, the transport of hopper dredges to and from the offshore borrow areas could result in an encounter with humpback and NARW species.

c. Project Impacts.

(1) Habitat. No critical habitat has been designated for NARWs and humpback whales within the proposed project area.

(2) Food Supply. North Atlantic right whales feed primarily on copepods (*Calanus* sp.) and euphausids (krill) (NMFS, 1991) and humpback whales feed on small fish and krill. The proposed dredging will not diminish productivity of the nearshore ocean; therefore, the food supply of these species should be unaffected.

(3) Relationship to Critical Periods in Life Cycle.

North Atlantic Right Whale (NARW).

Detailed life history information for NARWs and potential effects from dredging activities area provided within the following Section 7 consultation documents:

National Marine Fisheries Service. 1997. Regional Biological Opinion for the Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland

USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE, Wilmington District. Submitted to NMFS on 12 September 2008.

The referenced September 2008 Section 7 consultation document discusses in detail the 26 June, 2006 proposed regulations by NMFS to implement mandatory vessel speed restrictions of 10 knots or less on vessels 65 ft. or greater in overall length in certain locations and at certain times of the year along the east coast of the U.S. Atlantic seaboard. Following the release of the referenced USACE consultation document, NMFS announced the release of the Final Rule and subsequent OMB approval of the collection-of-information requirements. Specifically, on October 10, 2008 NMFS published a final rule implementing speed restrictions to reduce the incidence and severity of ship collisions with North Atlantic right whales (73 FR 60173) with an effective date of December 9, 2008 through December 9, 2013. That final rule contained a collection-of-information requirement subject to the Paperwork reduction Act (PRA) that had not yet been approved by OMB. Specifically, 50 CFR 224.105(c) requires a logbook entry to document that a deviation from the 10-knot speed limit was necessary for safe maneuverability under certain conditions. On October 30, 2008, OMB approved the collection-of-information requirements contained in the October 10, 2008, final rule. On 5 December 2008, NMFS announced that the collection-of-information requirements were approved under Control Number 0648–0580, with an expiration date of April 30, 2009 (15 CFR Part 902).

Humpback Whales.

The overall North Atlantic population of humpback whales is estimated at 10,600 individuals and is increasing (Waring *et al*., 1999); however the minimum population estimates for the Gulf of Maine stock is 647 individuals with a steadily increasing trend (NMFS, 2003). For the period 1993-1997, the total estimated human-caused mortality and serious injury from fishery interactions and vessel collisions is estimated at 4.4 per year (NMFS, 2003). According to Jensen and Silber's (2003) large whale ship strike database, of the 292 records of confirmed or possible ship strikes to large whales, 44 records (15%) were of humpback whales, the second most often reported species next to finback whales (75 records) (26%). Of the 5 documented ship strikes resulting in serious injury or mortality for North Atlantic humpback whales from January 1997-December 2001, 3 where located in North Carolina and South Carolina waters. Though the total level of human-caused mortality and serious injury is unknown, current data indicate that it is significant; furthermore, mortality off the U.S. Mid-Atlantic States continues to increase (NMFS, 2003).

(4) Effect Determination. Of the six species of whales being considered, only the NARW and humpback whale would normally be expected to occur within the project area during the project construction period. Therefore, the proposed project is not likely to adversely affect the blue whale, finback whale, sei whale, and sperm whale. Conditions outlined in previous consultations in order to reduce the potential for accidental collision (i.e. contractor pre-project briefings, large whale observers, slow down and course alteration procedures, etc.) will be implemented as a component of this project. Based on the implementation of these conditions, dredging activities associated with the proposed project may affect but are not likely to adversely affect the NARW and humpback whale species.

3.02.3 West Indian Manatee

a. Status. Endangered.

b. Occurrence in Immediate Project Vicinity. The manatee is an occasional summer resident off the North Carolina coast with presumably low population numbers (Clark, 1987). The species can be found in shallow (5 ft to usually <20 ft), slow-moving rivers, estuaries, saltwater bays, canals, and coastal areas (USFWS, 1991). The West Indian manatee is herbivorous and eats aquatic plants such as hydrilla, eelgrass, and water lettuce (USFWS, 1999a). Manatees are thermally stressed at water temperatures below 18ºC (64.4ºF) (Garrot *et al*., 1995); therefore, during winter months, when ambient water temperatures approach 20ºC (68ºF), the U.S. manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. During the summer months, sightings drop off rapidly north of Georgia (Lefebvre *et al., 2001*) and are rare north of Cape Hatteras (Rathbun *et al., 1982*; Schwartz, 1995). However, they are sighted infrequently in southeastern North Carolina with most records occurring in July, August, and September, as they migrate up and down the coast (Clark, 1993). The Species is considered a seasonal inhabitant of North Carolina with most occurrences reported from June through October (USFWS, 2001). According to Schwartz (1995), manatees have been reported in the state during nine months, with most sightings in the August-September period. Manatee population trends are poorly understood, but deaths have increased steadily. A large percent of mortality is due to collisions with watercrafts, especially of calves. Another closely related factor in their decline has been the loss of suitable habitat through incompatible coastal development, particularly destruction of sea grass beds by boating facilities (USFWS, 2001).

Manatees are rare visitors to the SCNTB Region. According to Schwartz (1995), a total of 68 manatee sightings have been recorded in 11 coastal counties of North Carolina during the years 1919-1994. Therefore, it is likely that manatees transit through the SCNTB region during the warm water months. Manatees are known to infrequently occur within nearly all North Carolina ocean and inland waters (Schwartz, 1995) with four North Carolina records having been from inlet-ocean sites and six from the open ocean (Rathbun, 1982). According to the existing literature, specific numbers of manatees using the region are not known but are presumed to be very low. More research is needed to determine the status of the species in North Carolina and identify areas (containing food and freshwater supplies), which support summer populations.

c. Current Threats to Continued Use of the Area. Current threats to this species in the SCNTB area cannot be clearly assessed due to our lack of knowledge regarding its population, seasonality, distribution, and the habitat components in the project area that may be needed for its use. However, considering that manatees become thermally stressed at water temperatures below 18ºC (64ºF) (Garrot *et al*., 1995), cold winter temperatures keep the species from over wintering in the project area.

d. Project Impacts.

(1) Habitat. Impacts to estuarine and nearshore ocean habitat of the area associated with the placement of sediment on the beach should be minor. With the current state of knowledge on the habitat requirements for the manatee in North Carolina, it is difficult to determine the magnitude of such impacts. Studies currently underway by the USFWS using animals fitted with satellite transmitters will hopefully provide data on the nature of these seasonal movements and habitat requirements during migrational periods.

(2) Food Supply. Foods, which are used by the manatee in North Carolina, are unknown. In Florida, their diet consists primarily of vascular plants. The proposed action will involve minimal change to the physical habitat of the estuary with no known impacts to vascular plants and overall estuarine and nearshore productivity should remain high throughout the project area. Therefore, potential food sources for the manatee should be unaffected.

(3) Relationship to Critical Periods in Life Cycle. Since the manatee is considered to be an infrequent summer resident of the North Carolina coast, the proposed action should have little effect on the manatee since its habitat and food supply will not be significantly impacted. In regards to vessel collisions, the proposed borrow sites are located between 1-6 miles offshore and the hopper dredge pumpout stations will be located within a mile offshore; thus, hopper dredging activities will not occur in the estuarine or inlet habitat area and direct impacts from collision will not occur. Nonetheless, the Corps will implement precautionary measures for avoiding impacts to manatees from associated transiting vessels during construction activities, as detailed in the “Guidelines for Avoiding Impacts to the West Indian Manatee” established by the USFWS.

(4) Effect Determination. Since the habitat and food supply of the manatee will not be significantly impacted, overall occurrence of manatees in the project vicinity is infrequent, all hopper dredging will occur in the offshore environment, and precautionary measures for avoiding impacts to manatees, as established by USFWS, will be implemented for transiting vessels associated with the project, the proposed action may affect by is not likely to adversely affect the manatee.

3.02.4 Sea Turtles.

a. Status.

Loggerhead	*Caretta caretta*	Threatened
Hawksbill	*Eretmochelys imbricata*	Endangered
Kemp's Ridley	*Lepidochelys kempii*	Endangered
Green	*Chelonia mydas*	Threatened[1]
Leatherback	*Dermochelys coriacea*	Endangered

[1]Green turtles are listed as threatened, except for breeding populations in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

b. Critical Habitat. Critical habitat has not been designated in the continental U.S. for the five species of sea turtles identified to occur within the proposed project vicinity. Therefore, the proposed actions would not result in an adverse modification to identified critical habitat.

c. Background. Detailed life history information associated with the in-water life cycle requirements for sea turtles and a subsequent analysis of impacts from the proposed dredging activities is provided within the following NMFS Section 7 consultation documents:

National Marine Fisheries Service. 1997. Regional Biological Opinion for the Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland

USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE, Wilmington District. Submitted to NMFS on 12 September 2008

A summary of project specific information associated with beach and in-water habitat use is provided in the ensuing text.

1.) Occurrence in Immediate Project Vicinity. All five species of sea turtles identified above are known to occur in both the estuarine and oceanic waters of North Carolina. According to Epperly *et al.* (1994), inshore waters, such as Pamlico and Core Sounds, are important developmental and foraging habitats for loggerheads, greens, and Kemp's ridleys. Nearly all sea turtles found within these sounds are immature individuals immigrating into the sounds in the spring and emigrating from the sounds in the late fall and early winter (Epperly et. al, 1995).

Loggerhead, green, and Kemp's ridley sea turtles are known to frequently use coastal waters offshore of North Carolina as migratory travel corridors (Wynne, 1999) and commonly occur at the edge of the continental shelf when they forage around coral reefs, artificial reefs, and boat wrecks.

Hawksbill and leatherback sea turtles infrequently enter inshore waters (Epperly *et al.*, 1995) and are normally associated solely with oceanic waters (Schwartz, 1977). However, Lee and Palmer (1981) document that leatherbacks normally frequent the shallow shelf waters rather than those of the open sea, with the exception of long-range migrants.

Of the five species of sea turtles considered for this project, only the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*), and the leatherback sea turtle (*Dermochelys coriacea*) nest regularly on North Carolina beaches and have the potential to nest within the project area. There are no documented nesting attempts of hawksbill and Kemp's ridley sea turtles on the project beaches; however, Kemp's ridley nests have been documented twice in North Carolina, once on Oak Island in 1992 and once on Cape Lookout in 2003 ((Matthew Godfrey, pers. comm.). With a few exceptions, the entire Kemp's ridley population nests on the approximately 15 miles of beach in Mexico between the months of April and June (USFWS, 1991). The hawksbill sea turtle nests primarily in tropical waters in south Florida and the Caribbean. Considering the infrequency of Kemp's ridley nesting occurrence throughout North Carolina and the lack of historical nesting of Kemp's ridley and hawksbill sea turtles on Topsail Island, these species are not anticipated to nest within the project area. The loggerhead is considered to be a regular nester in the state, while green sea turtle nesting is infrequent and primarily limited to Florida's east coast (300 to 1,000 nests reported annually). According to Rabon *et al*. (2003), seven leatherback nests have been confirmed in North Carolina since 1998 constituting the northernmost nesting records for leatherbacks along the East Coast of the United States. Though almost all confirmed nesting activity in North Carolina has been between Cape Lookout and Cape Hatteras, the potential for leatherback nesting within the project area is likely.

Topsail Island is considered to be one of the more heavily nested areas along the North Carolina coast. Table 3, shows the total number of recorded loggerhead and green sea turtle nests on SCNTB beaches from 1990 to 2008. Though records were kept as early as 1984, consistent turtle nesting data has been recorded on Topsail Island only since 1990. Furthermore, Standardized nest patrols were not enacted statewide until the mid 1990s; therefore, values from the first part of the 1990's may not represent a full season of monitoring. Of the 1483 nests laid within the project areas since 1990, loggerhead sea turtles laid 1471 nests and 12 nests were laid by greens (Matthew Godfrey, pers. comm.). As shown in Table 3, sea turtle nesting numbers declined following hurricanes in the 1990's - Hurricane Emily, 1993, Hurricanes Bertha and Fran, 1996, and Hurricane Floyd, 1999. As part of the terms of local cooperation for this project, the project area will be monitored for sea turtle nesting and hatchling activity on an annual basis by the towns of Surf City and North Topsail Beach.

Table 3. Total sea turtle nest numbers for Surf City and North Topsail Beaches from 1990-2008. Loggerhead and green sea turtles are the only species with recorded nesting activity on Surf City and North Topsail beaches.

Year	Loggerhead (*Caretta caretta*)	Green (*Chelonia mydas*)
1990	68	0
1991	116	0
1992	91	0
1993	53	0
1994	80	0
1995	71	0
1996	102	1
1997	61	1
1998	89	3
1999	152	6
2000	87	0
2001	62	0
2002	77	0
2003	52	0
2004	49	0
2005	59	1
2006	77	0
2007	46	0
2008	79	0
TOTAL	1471	12

2.) Current Threats to Continued Use of the Area. In addition to affecting the coastal human population, coastal sediment loss also poses a threat to nesting sea turtles. A large percentage of sea turtles in the United States nest on nourished beaches (Nelson and Dickerson, 1988a), therefore, nourishment has become an important technique for nesting beach restoration (Crain *et al.*, 1995). Most of the project area has experienced severe erosion because of frequent hurricanes passing over or near the area since 1996. Since consistent turtle nesting surveys began on Topsail Island in 1990, there has been a gradual decline in the average numbers of nests laid per year (Table I-2). Coupled with this decline is the increase in nest relocations for those that are laid. One potential cause for decreased nest numbers and increased relocation numbers is loss of nesting habitat (Jean Beasley, pers. comm.). In areas were erosion is most severe, the tide is so high there is not acceptable beach to nest and without relocation efforts in these highly erosive areas, nests will be inundated and lost. Though concerns about beach nourishment, as it relates to relocation and nest success, are evident, with overall loss of habitat over time due to erosion, there will be complete loss of nesting on Topsail Island (Jean Beasley, pers. comm.).

Topsail Island is considered to be one of the major rookeries for the declining Northern loggerhead population; thus restoration of this important nesting habitat on Topsail Island is critical. Historically, the north and south ends of Topsail Island have experienced beach disposal operations from the maintenance of navigation channels. These small-scale disposal events have re-established lost nesting habitat and have allowed for some turtles to continue nesting in areas that would have otherwise been lost. In regards to suitability for nesting, turtles continue to nest on disposal beaches with hatch rate successes similar to non-disposal beaches (Jean Beasley, pers. comm.).

The primary threats facing these species worldwide are the same ones facing them in the project area. Of these threats, the most serious seem to be loss of breeding females through accidental drowning by shrimpers (Crouse, *et al.*, 1987) and human encroachment on traditional nesting beaches. Research has shown that the turtle populations have greatly declined in the last 20 years due to a loss of nesting habitat along the beachfront and by incidental drowning in shrimp trawl nets. It appears that the combination of poorly placed nests coupled with unrestrained human use of the beach by auto and foot traffic has impacted this species greatly. Other threats to these sea turtles include excessive natural predation in some areas and potential interactions with hopper dredges during the excavation of dredged material. With the exception of hopper dredges, none of the dredge plants (i.e., pipeline dredges) proposed for use in the construction of this project are known to take sea turtles.

d. Project Impacts.

In order to avoid periods of peak sea turtle abundance during warm water months and minimize impacts to sea turtles in the offshore environment, the proposed hopper dredging window for this project is 1 December through 31 March. By adhering to this dredging window to the maximum extent practicable, all subsequent beach placement of sediment will occur outside of the North Carolina sea turtle nesting season of 1 May through 15 November. The limits of the nesting season window are based on the known nesting sea turtle species within the state and the earliest and latest documented nesting events for those species.

In the unanticipated event that construction activities extend into the nesting season (i.e. weather, equipment breakdown, etc.), all available data associated with the nesting activities within the project area will be utilized to consider risks of working within the nesting season. Variables to consider will include the number of days construction will extend into the nesting season, existing conditions of the pre-project nesting habitat such as: erosion rates, existing protective measures (i.e. sandbags, beach bulldozing, etc.), development, recreational use, the historic nesting density within the project area, etc. In coordination with the USFWS and NCWRC, an evaluation of these variables will be used to potentially incorporate project modifications (i.e. modified pipeline routes, staging areas, etc.) during the nesting season that may avoid or minimize potential impacts.

Upon evaluation of site-specific conditions, if nourishment beach activities extend into a portion of the nesting season, monitoring for sea turtle nesting activity will be considered throughout the construction area including the disposal area and beachfront pipeline routes, in accordance with guidelines provided by the NCWRC and USFWS, so that nests laid in a potential construction zone can be bypassed and/or relocated outside of the construction zone prior to project commencement. However, relocation measures should be considered as a last alternative. The location and operation of heavy equipment on the beach within the project area will be limited to daylight hours to the maximum extent practicable in order to minimize impacts to nesting sea turtles.

Considering that the proposed 1 December to 31 March construction window for initial construction and each nourishment interval will avoid the nesting season, direct impacts associated with construction activities during the nesting season are not anticipated and will be avoided to the maximum extent practicable. However, if construction extends into the nesting season do to unforeseen circumstances, the following direct impacts may occur:

(1) Both stockpiled pipe on the beach and the pipeline route running parallel to the shoreline may impede nesting sea turtles from accessing more suitable nesting sites.
(2) The operation of heavy equipment on the beach may impact incubating nests.
(3) During nighttime operations, the nourishment construction process, including heavy equipment use and associated lighting, may deter nesting females from coming ashore and disorient emerging hatchlings down the beach.
(4) Burial of existing nests may occur if missed by monitoring efforts.
(5) Escarpment formations and resulting impediment to nesting females.
(6) Reduced nest success as a result of relocation efforts.

Indirect impacts associated with changes to the nesting and incubating environment, from the placement of sediment from alternate sources on the beach, are expected. The following section discusses both potential direct and indirect impacts to nesting sea turtles associated with the proposed project:

(1) <u>Beach Placement of Sediment Impacts</u>.

Post-nourishment monitoring efforts have documented potential impacts on nesting loggerhead sea turtles for many years (Fletemeyer, 1984; Raymond, 1984; Nelson and Dickerson, 1989; Ryder, 1993; Bagley *et al*., 1994; Crain *et al*., 1995; Milton *et al*., 1997; Steinitz *et al.*, 1998; Trindell *et al*., 1998; Davis *et al*., 1999; Ecological Associates, Inc., 1999; Herren, 1999; Rumbold *et al*., 2001; Brock, 2005). Results from these studies indicate that, in most cases, nesting success decreases during the year following nourishment as a result of escarpments obstructing beach accessibility, altered beach profiles, and increased compaction. A comprehensive post-nourishment study conducted by Ernest and Martin (1999) documented an increase in abandoned nest attempts on nourished beaches compared to control or pre-nourished beaches as well as a change in nest placement with subsequent increase in wash-out of nests during the beach equilibration process. Contrary to previous studies, this study suggests that a post-nourishment decline in nest success is more likely a result from changes in beach profile than an increase in beach compaction and escarpment formation. According to Brock (2005), the sediment used for the nourishment of Brevard County beaches in Florida offered little or no impediment to sea turtles attempting to excavate an egg chamber. Furthermore, the physical attributes of the nourished sediment did not facilitate excessive scarp formation and; therefore, turtles were not limited in their ability to nest across the full width of beach. However, a decrease in nest success was still documented in the year following nourishment with an increase in loggerhead nesting success rates during the second season post-nourishment. This was attributed to increased habitat availability following the equilibration process of the seaward crest of the berm. This study suggests that, if compatible sediment and innovative design methods are utilized to minimize post-nourishment impacts documented in previous studies, than the post-nourishment decrease in nest success without the presence of scarp formations, compaction, etc. may indicate an absence of abiotic and or biotic factors that cue the female to initiate nesting.

As suggested by the historical literature, there are inherent changes in beach characteristics as a result of mechanically placing sediment on a beach from alternate sources. The change in beach characteristics often results in short-term decreases in nest success and/or alterations in nesting processes. Based on the available literature, it appears that these impacts are, in many cases, site specific. Careful consideration must be placed on pre- and post-project site conditions and resultant beach characteristics after beach-fill episode at a given site in order to thoroughly understand identified post-project changes in nesting processes. By better understanding potential project specific impacts, modifications to project templates and design can be implemented to improve habitat suitability. The following sections review, more specifically, documented direct or indirect impacts to nesting females and hatchlings.

a. Pipe Placement.

In the event unanticipated circumstances arise and construction operations extend into the sea turtle nesting season pipeline routes and pipe staging areas may act as an impediment to nesting females approaching available nesting habitat or to hatchlings orienting to the waters edge. If the pipeline route or staging areas extend along the beach face, including the frontal dune, beach berm, mean high water line, etc., some portion of the available nesting habitat will be blocked. Nesting females may either encounter the pipe and false crawl, or nest in front of the pipeline in a potentially vulnerable area to heavy equipment operation, erosion, and washover. If nests are laid prior to placement of pipe and are landward of the pipeline, hatchlings may be blocked or mis-oriented during their approach to the water.

Though pipeline alignments and staging areas may pose impacts to nesting females and hatchlings during the nesting season, several measures can be implemented to minimize these impacts. If construction activities extend into the nesting season, monitoring should be done in advance to document all nests within the beach placement template. Construction operations and pipeline placement could be modified to bypass existing nests. If bypassing is not a practical alternative for a given project, the relocation of nests outside of construction areas could be implemented as a last resort. Throughout the period of sea turtle nesting and hatching, construction pipe that is placed on the beach parallel to the shoreline could be placed as far landward as possible so that a significant portion of available nesting habitat can be utilized and nest placement is not subject to inundation or wash out. Furthermore, temporary storage of pipes and equipment can be located off the beach to the maximum extent practicable. If placement on the beach is necessary, it will be done in a manner so as to impact the least amount of nesting habitat by placing pipes perpendicular to shore and as far landward as possible without compromising the integrity of the existing or constructed dune system.

b. Slope and Escarpments.

Beach nourishment projects are designed and constructed to equilibrate to a more natural profile over time relative to the wave climate of a given area. Changes in beach slope as well as the development of steep escarpments may develop along the mean high water line as the constructed beach adjusts from a construction profile to a natural beach profile (Nelson *et al.*, 1987). For the purposes of this assessment, escarpments are defined as a continuous line of cliffs or steep slopes facing in one general direction, which is caused by erosion or faulting. Depending on shoreline response to the wave climate and subsequent equilibration process for a given project, the slope both above and below mean high water may vary outside of the natural beach profile; thus resulting in potential escarpment formation. Though escarpment formation is a natural response to shoreline erosion, the escarpment formation as a result of the equilibration process during a short period following a nourishment event may have a steeper and higher vertical face than natural escarpment formation and may slough off more rapidly landward.

Adult female turtles survey a nesting beach from the water before emerging to nest (Carr and Ogren, 1960; Hendrickson, 1982). Parameters considered important to beach selection include the geomorphology and dimensions of the beach (Mortimer, 1982; Johannes and Rimmer, 1984) and bathymetric features of the offshore approach (Hughes, 1974; Mortimer, 1982). Beach profile changes and subsequent escarpment formations may act as an impediment to a nesting female resulting in a false crawl or nesting females may choose marginal or unsuitable nesting areas either within the escarpment face or in front of the escarpment. Often times these nests are vulnerable to tidal inundation or collapse of the receding escarpment. If a female is capable of nesting landward of the escarpment prior to its formation, as the material continues to slough off and the beach profile approaches a more natural profile, there is a potential for an incubating nest to collapse or fallout during the equilibration process. Loggerheads preferentially nest on the part of the beach where the equilibration process takes place (Brock, 2005; Ecological Associates, Inc., 1999) and are more vulnerable to fallout during equilibration. However, according to Brock (2005), the majority of green turtle nests are placed on the foredune and; therefore, the equilibration process of the nourished substrate may not affect green turtles as severely.

A study conducted by Ernest and Martin (1999) documented increased abundance of nests located further from the toe of the dune on nourished vs. control beaches. Thus, post-nourishment nests may be laid in high-risk areas where vulnerability to sloughing and equilibration are greatest. Though nest relocation is not encouraged, considering that immediately following nourishment projects the likelihood of beach profile equilibration and subsequent sloughing of escarpments as profile adjustment occurs, nest relocation may be used as a last alternative to move nests that are laid in locations along the beach that are vulnerable to fallout (i.e. near the mean high water line). As a nourished beach is re-worked by natural processes and the construction profile approaches a more natural profile, the frequency of escarpment formation declines and the risk of nest loss due to sloughing of escarpments is reduced. According to Brock (2005), the return of loggerhead nesting success to equivalent rates similar to those on the adjacent non-nourished beach and historical rates two seasons post-nourishment were observed and are attributed to the equilibration process of the seaward crest of the berm.

Though the equilibration process and subsequent escarpment formation are features of most beach projects, management techniques can be implemented to reduce the impact of escarpment formations. For completed sections of beach during beach construction operations, and for subsequent years following as the construction profile approaches a more natural profile, visual surveys for escarpments could be performed. Escarpments that are identified prior to or during the nesting season that interfere with sea turtle nesting (exceed 18 inches in height for a distance of 100 ft.) can be leveled to the natural beach for a given area. If it is determined that escarpment leveling is required during the nesting or hatching season, leveling actions will be directed by the NCWRC and USFWS.

The Corps' Jacksonville, FL District Headquarters is currently working with the Florida DEP to identify aspects of beach nourishment construction templates that negatively impact sea turtles and develop alternative design criteria that may minimize these impacts. Project design modifications to develop a more "turtle friendly" beach profile could potentially increase post-nourishment nest density and success. A draft final report for phase one of this study, "Assessment of Alternative Construction Template for Beach Nourishment Projects," has been developed and reviewed. Based on the final results and feasibility of recommendations, the Corps may incorporate, to the maximum extent practicable, 'turtle friendly' beach profile criteria in future project designs in order to enhance sea turtle nesting habitat requirements; however, at this point in time no formal recommendations have been identified.

c. Incubation Environment.

Physical changes in sediment properties that result from the placement of sediment, from alternate sources, on the beach pose concerns for nesting sea turtles and subsequent nest success. Constructed beaches have had positive effects (Broadwell, 1991; Ehrhart and Holloway-Adkins, 2000; Ehrhart and Roberts, 2001), negative effects (Ehrhart, 1995; Ecological Associates, Inc., 1998), or no apparent effect (Raymond, 1984.; Nelson *et al*., 1987; Broadwell, 1991; Ryder, 1993; Steinitz *et. al*., 1998; Herren, 1999) on the hatching success of marine turtle eggs. Differences in these findings are related to the differences in the physical attributes of each project, the extent of erosion on the pre-existing beach, and application technique (Brock, 2005).

If nesting occurs in new sediment following beach construction activities, embryonic development within the nest cavity can be affected by insufficient oxygen diffusion and variability in moisture content levels within the egg clutch (Ackerman, 1980; Mortimer, 1990; Ackerman *et al*., 1992); thus, potentially resulting in decreased hatchling success. Ambient nest temperature and incubation time are affected by changes in sediment color, sediment grain size, and sediment shape as a result of beach nourishment (Milton *et al*., 1997) and; thus, affect incubation duration (Nelson and Dickerson, 1988a). Sexual differentiation in chelonians depends on the temperature prevailing during the critical incubation period of the eggs (Pieau, 1971; Yntema, 1976; Yntema and Mrosovsky, 1979; Bull and Vogt, 1979), which occurs during the middle third of the incubation period (Yntema, 1979; Bull and Vogt, 1981; Pieau and Dorizzi, 1981; Yntema and Mrosovsky, 1982; Ferguson and Joanen, 1983; Bull, 1987; Webb *et al*. 1987; Deeming and Ferguson, 1989; Wibbels *et al*., 1991), and possibly during a relatively short period of time in the second half of the middle trimester (Webster and Gouviea, 1988). Eggs incubated at constant temperatures of 28°C or below develop into males. Those kept at 32°C or above develop into females. Therefore, the pivotal temperature, those giving approximately equal numbers of males and females, is approximately 30°C (Yntema and Mrosovsky, 1982). Estimated pivotal temperatures for loggerhead sea turtles nesting in North Carolina, Georgia, and southern Florida are close to 29.2°C (Mrosovsky and Provancha, 1989). Therefore, fluctuation in ambient nest temperature on constructed beaches could directly impact sex determination if nourished sediment differs significantly from that found on the natural beach. Since, the pivotal temperatures for the northern and southern geographic nesting ranges of loggerheads in the United States are similar, a higher percentage of males are produced on North Carolina beaches and a higher percentage of females on Florida beaches. Hatchling sex ratios are of conservational significance (Mrosovsky and Yntema, 1980; Morreale *et al*., 1982) since they may affect the population sex ratio and thus could alter reproductive success in a population (Hanson *et al*., 1998).

This assessment assumes sediment being placed on the beach meets the new state Sediment Criteria Rule Language (15A NCAC 07H .0312) (http://dcm2.enr.state.nc.us/Rules/rules.htm) for borrow material and subsequent beach placement adopted by North Carolina Coastal Resources Commission (CRC). Therefore, sediment characteristics will be compatible with native beaches.

d. Nest Relocation.

Relocation of sea turtle nests to less vulnerable sites was once common practice throughout the southeastern U.S. to mitigate the effects of natural or human induced factors. However, the movement of eggs creates opportunities for adverse impacts. Therefore, more recent USFWS guidelines are to be far less manipulative with nests and hatchlings to the maximum extent practicable. Though not encouraged, nest relocation is still used as a management technique of last resort where issues that prompt nest relocation cannot be resolved. Potential adverse impacts associated with nest relocation include: survey error (Shroeder, 1994), handling mortality (Limpus *et al.* 1979; Parmenter 1980), incubation environment impacts (Limpus *et al*., 1979; Ackerman, 1980; Parmenter, 1980; Spotila *et al*., 1983; McGehee, 1990), hatching and emergence success, and nest concentration.

Construction efforts associated with this project are scheduled, to the maximum extent practicable, to work outside of the sea turtle nesting season in order to avoid impacts to nesting females and the nest incubation environment. However, in some instances where an extension into the nesting season cannot be avoided, nest relocation may be used as a management tool to re-locate nests laid in the impact area to areas that are not susceptible to disturbance. For the identified project area, if the earliest documented nest attempt precludes the project completion date, nest relocation may be used as a last resort mitigation effort. If relocation is implemented, the proper protocol established by the NCWRC and USFWS will be adhered to in order to avoid the potential adverse impacts outlined above.

e. Beach Compaction and Hardness.

Sediment placed on the beach, as a component of coastal storm damage reduction projects, beach disposal, sand-bypassing, etc. is often obtained from three main sources: inlets, channels, or offshore borrow sites (Crain *et al*., 1995) with occasional use of upland sources. Significant alterations in beach substrate properties may occur with the input of sediment types from other sources. Sediment density (compaction), shear resistance (hardness), sediment moisture content, beach slope, sediment color, sediment grain size, sediment grain shape, and sediment grain mineral content can be changed by beach nourishment.

Current sea turtle literature has attributed post-nourishment beach hardness to sand compaction but it should be more appropriately attributed to sediment shear resistance. Increased shear resistance can be due to increased sand compaction (density), but it can also be due to other factors such as sand particle characteristics (size, shape) and interactions between the particles (Spangler and Handy, 1982; Nelson *et al.*, 1987; Nelson and Dickerson, 1989; Ackerman, 1996). Shear resistance describes the ability of the beach sand to resist sliding along internal surfaces. A measure of shear resistance can be described as a measure of beach hardening or strength. The sand particle surface characteristics contribute to the sliding friction ability of the sand particles. Various parameters (chemical composition, cohesion, moisture content, sediment layering and mixing) contribute to the interlocking ability of the sand particles. Sliding friction, interlocking, and compaction of the sand particles all contribute to a measure of shear resistance. Thus, a measurement of increased shear resistance does not necessarily mean that the beach is also compacted (Ackerman, 1996).

Factors which may contribute to increased beach hardness (shear resistance) on nourished beaches include a high silt component, angular fine-grained sand, higher moisture content, equipment and vehicular traffic, and hydraulic slurry deposition of sediments (Nelson, 1985; Nelson *et al.*, 1987; Nelson and Dickerson, 1988a; 1989; Ackerman, 1996). Beach fill can vary in amount of carbonate sand, quartz sand, shell, coral, silt, and clay content (National Research Council 1995). Sediments used for beach fill with clay or silt contents higher than 5-10% may cause high beach hardness once the sediment dries (Nelson, 1985; Dean, 1988). Harder nourished beaches typically result from angular, finer grain sand dredged from stable offshore borrow sites; whereas, less hard or "softer" beaches result from smoother, coarse sand dredged from high energy locations (e.g. inlets) (Spangler and Handy 1982; Nelson *et al.,* 1987; Nelson and Dickerson 1988a; 1989). Nourished beaches may result in sediment moisture content more than 4% higher than adjacent, natural beaches (Ackerman 1996, Ackerman *et al.,* 1992). Placement of fill material with heavy equipment imparts a component of "compactness" that should not occur on natural beaches. The natural process of beach formation, over an extended period of time, results in extensive sorting of the sand both by layers and within layers. Layer orientation is determined by the wave wash which is not the same for nourished beaches (National Research Council, 1995).

Hard sediment can prevent a female from digging a nest or result in a poorly constructed nest cavity. Females may respond to harder physical properties of the beach by spending more time on the beach nesting, which may result in physiological stress and increased exposure to disturbances and predation; thus, in some cases leading to a false dig (Nelson and Dickerson, 1989). Although increased shear resistance does not occur with every nourishment project, higher shear resistance measurement values have been more frequently reported over the past 30 years from nourished beaches than on natural beaches of the same area (e.g. Mann 1977; Fletemeyer 1983; Raymond 1984; Nelson *et al.,* 1987; Moulding and Nelson 1988; Nelson and Dickerson 1988a; Ryder 1995; Bagley *et al.*, 1994; Crain *et al.,* 1995; Ernest *et al.,* 1995; Foote and Truitt 1997; Milton *et al.,* 1997; Steinitz *et al.,* 1998; Trindell *et al.*, 1998; Davis *et al.,* 1999; Herren 1999; Allman *et al.*, 2001; Rumbold *et al.,* 2001; Piatkowski, 2002; Scianna *et al.,* 2001; Brock, 2005). Results have varied tremendously on the nesting success reported in these studies when comparing nourished and natural beaches of different shear resistance values. The natural variance in shear resistance values and the nesting success related to these values is still poorly understood. Due to the many variables involved from natural and non-natural causes, it is extremely difficult to identify impacts from nourishment projects by only evaluating nesting success data. Analyses of shear resistance values and nesting success have yet to determine a consistent relationship (Trindell *et al.*, 1998). It is difficult to define absolute or optimal shear resistance values until these relationships are better understood throughout the sea turtle nesting range in the

United States (Gulf and South Atlantic states). Crain *et al.* (1995) also recommended this as a research priority for beach nourishment impact studies.

Measuring shear resistance has become a common procedure of most beach nourishment projects and is usually done with a hand-held cone-penetrometer (Crain et al 1995). While holding the instrument in a vertical orientation, measurements are obtained by manually pushing it into the beach sediment. Based on data collected during the 1980's from nourished and non-nourished projects on the Atlantic coast of Florida, the U.S. Army Corps of Engineers provided initial guidelines on maximum cone-penetrometer values (600) below which might be more compatible with natural nesting beaches (Nelson *et al..,* 1987; Moulding and Nelson 1988; Nelson *et al.,* 1987; Nelson and Dickerson 1988a; 1989). The USFWS later adopted these guidelines into permitting regulations for all nourished projects along the U.S. Atlantic and Gulf of Mexico coasts with potential sea turtle nesting habitat. These requirements are still in effect to date and are outlined in state construction permit requirements and Biological Opinions issued by USFWS. According to the general USFWS compaction measurement guidelines for NC outlined below, compaction measurements of 500 PSI establishes the level of beach hardness when post-nourishment beach tilling should be done to reduce the shear resistance measurements.

General USFWS Compaction Guidelines

1. Compaction sampling stations will be located at 500-foot intervals along the project area. One station will be at the seaward edge of the dune 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. Layers of highly compact material may lie 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 18 values for each transect line, and the final 6 averaged compaction values.

2. 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 May 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 randomly present within the project area, tilling will not be required. For all circumstances where tilling is implemented, the designated area shall be tilled to a depth of 36 inches. Tilling will be performed (i.e. overlapping rows, parallel and perpendicular rows, etc.) so that all portions of the beach are tilled and no furrows are left behind All tilling activities must be completed prior to May 1 in accordance with the following protocol..

Readings of cone index values can be roughly equated to pounds per square inch (psi). However, this is a relative value and caution should be used when attempting to compare cone index values in pounds per square inch to other sources of data (Moulding and Nelson 1988). Ferrel *et al.* (2002) and Piatkowski (2002) used a Lang penetrometer, as opposed to the cone-penetrometer, because readings are not influenced by the mass of the user. This is an issue when multiple people of varying mass and strength are conducting the measurements. Much of the variation in the compaction data could be due to variability inherent in the use of the cone-penetrometer itself. Ferrell *et al.* (2002) investigated the strengths and weaknesses of several different types of instruments that measure sediment compaction and shear resistance suggesting that other instruments may be more suitable for measuring beach compaction relative to sea turtle nesting behavior. Because of instrument error and given that turtles do not dig vertically in the same fashion as a penetrometer moves through the sediment layers, some have concluded that penetrometers are not appropriate for assessing turtle nesting limitations (Davis *et al.*, 1999). However, even with this limitation, the hand-held cone-penetrometer remains the accepted method for assessing post-nourishment beach hardness.

According to Davis *et al.* (1999), on the Gulf Coast of Florida (1) there was no relationship between turtle nesting and sediment compactness, (2) the compactness ranges and varies widely in both space and time with little rationale, (3) tilling has a temporary influence on compactness and no apparent influence on nesting frequency, (4) and current compactness thresholds of 500 psi are artificial. According to Brock (2005), the physical attributes of the fill sand for Brevard County beaches did not result in severe compaction and therefore did not physically impede turtles in their attempts to nest. Therefore, additional studies should be considered to evaluate the validity of this threshold (500 PSI) and its general application across all beaches as a means to assess beach-tilling requirements. If sediment characteristics are similar to the native beach and sediment grain sizes are homogenous, the resultant compaction levels will likely be similar to the native beach and tilling should not be encouraged. A study by Nelson and Dickerson (1988b) documented that a tilled nourished beach will remain un-compacted for up to one year; however, this was a site-specific study and for some beaches it may not be necessary to till beaches in the subsequent years following nourishment.

Beach hardness impacts can be minimized by using compatible sand in accordance with the new NC state Sediment Criteria Rule Language (15A NCAC 07H .0312) (http://dcm2.enr.state.nc.us/Rules/rules.htm). In some cases, though sediment placed on the beach is compatible with the native sediment characteristics and the resultant compaction is similar to the native beach, tilling is still encouraged regardless of compaction levels. It has been suggested that, in some cases, the process of tilling a beach, with compaction levels similar to native beach, may have an effect on sea turtle nesting behavior and nest incubation environment. Research on evaluating tilling impacts to nesting turtles is limited. Therefore, the idea of not tilling beaches (immediately following and/or during consecutive years after construction operations) where compatible sediments are used and compaction levels are similar to the native beach should be taken into consideration on a case-by-case basis in order to account for potential impacts of tilling activities on nest success.

Recognizing the recent literature on beach compaction measurements and associated tilling, as well as and the current concerns with the existing compaction evaluation and subsequent tilling process outlined in the USFWS general compaction guidelines, the Corps, in coordination with

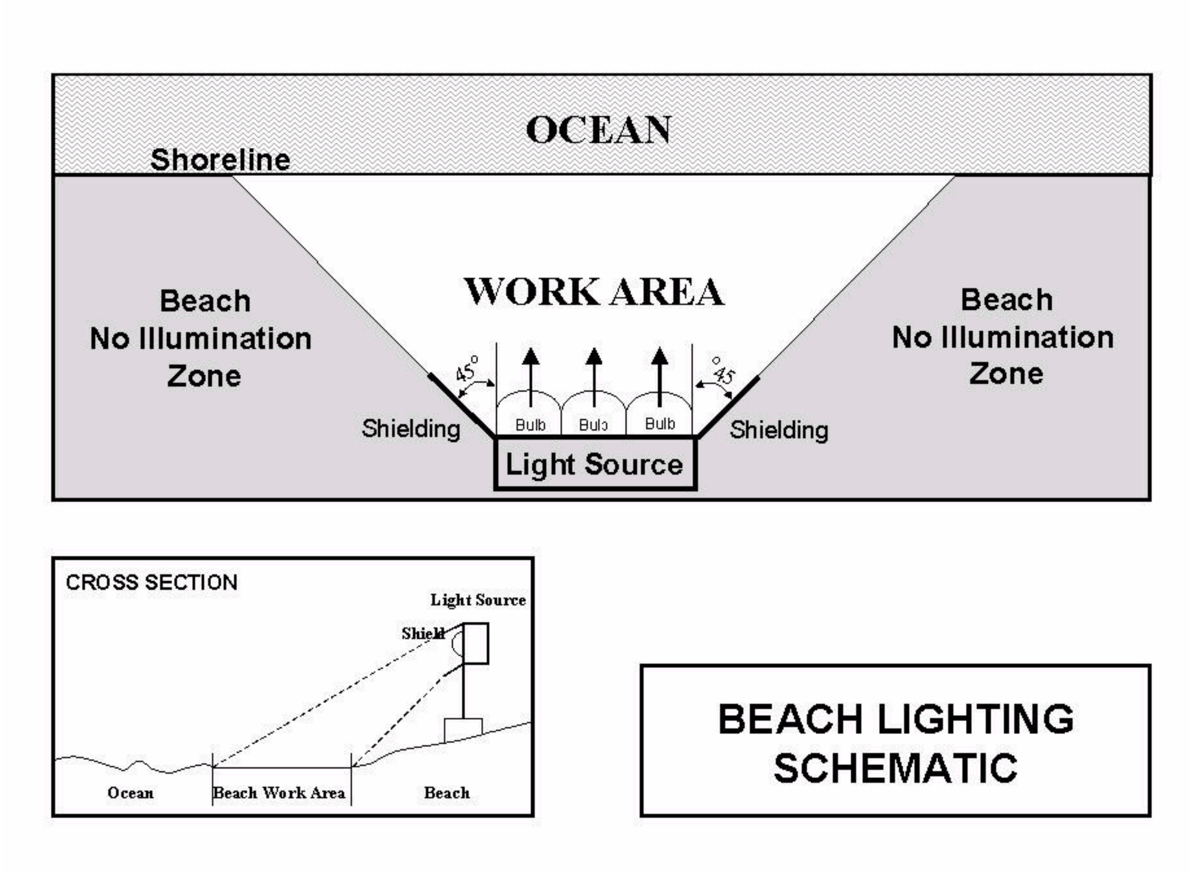
NCWRC and USFWS, has initiated a more qualitative approach for post construction compaction evaluations on North Carolina beaches where sediment meets the state compatibility standard. Results from this effort have recognized a reduction in the need for post construction tilling for many disposal and nourishment projects. Considering that only beach compatible sediment (i.e. in accordance with NC Sediment Criteria Rule Language) will be placed on the beach as a component of this project, the Corps will continue to work with NCWRC and USFWS in this qualitative post construction compaction and tilling evaluation in order to assure that impacts to nesting and incubating sea turtles are minimized.

f. Lighting.

The presence of artificial lighting on or within the vicinity of nesting beaches is detrimental to critical behavioral aspects of the nesting process including nesting female emergence, nest site selection, and the nocturnal sea-finding behavior of both hatchlings and nesting females. Artificial lighting on beaches tends to deter sea turtles from emerging from the sea to nest; thus, evidence of lighting impacts on nesting females is not likely to be revealed by nest to false crawl ratios considering that no emergence may occur (Mattison *et al*., 1993; Witherington, 1992; Raymond, 1984). Though nesting females prefer darker beaches (Salmon *et al*., 1995), considering the increased development and associated lighting on most beaches, many do nest on lighted shorelines. Although the effects of lighting may prevent female emergence, if emergence, nest site selection, and oviposition does occur, lighting does not affect nesting behavior (Witherington and Martin, 2003). However, sea turtles rely on vision to find the sea upon completion of the nesting process and use a balance of light intensity within their eyes to orient towards the brightest direction (Ehrenfeld, 1968); thus, misdirection by lighting may occur resulting in more time being spend to find the ocean. Furthermore, successful nesting episodes on lighted shorelines will directly effect the orientation and sea-finding process of hatchlings during the nest emergence and frenzy process to reach the ocean. Hatchlings rely almost exclusively on vision to orient to the ocean and brightness is a significant cue used during this immediate orientation process after hatch out (Mrosovsky and Kingsmill, 1985; Verheijen and Wilschut, 1973; Mrosovsky and Shettleworth, 1974; Mrosovsky *et al*., 1979). Hatchlings that are mis-oriented (oriented away from the most direct path to the ocean) or disoriented (lacking directed orientation or frequently changing direction or circling) from the sea by artificial lighting may die from exhaustion, dehydration, predation, and other causes. Though hatchlings use directional brightness of a natural light field (celestial sources) to orient to the sea, light from artificial sources interferes with the natural light cues resulting in misdirection (Witherington and Martin, 2003).

The impact of light on nesting females and hatchlings can be minimized by reducing the number and wattage of light sources or by modifying the direction of light sources through shielding, redirection, elevation modifications, etc. (Figure 1). If shielding of light sources is not effective, it is important that any light reaching the beach has spectral properties that are minimally disruptive to sea turtles like long wavelength light. The spectral properties of low-pressure sodium vapor lighting are the least disruptive to sea turtles among other commercially available light sources.

Figure 1. Schematic for recommended shielding of lighting associated with beach construction activities.



During beach placement construction operations associated with the proposed project, lighting is required during nighttime activities at both the pumpout site and the location on the beach where sediment is being placed. In compliance with the US Army Corps of Engineers Safety and Health Requirements Manual (2003), a minimum luminance of 30 lm/ft^2 is required for dredge operations and a minimum of 3 lm/ft^2 is required for construction activities on the beach. For dredging vessels, appropriate lighting is necessary to provide a safe working environment during nighttime activities on deck (i.e. general maintenance work deck, endangered species observers, etc.). During beach construction operations, lighting is generally associated with the active construction zone around outflow pipe and the use of heavy equipment in the construction zone (i.e. bulldozers) in order to maintain safe construction operations at night. Furthermore, on newly nourished beaches where the elevation of the beach berm is raised for coastal storm damage reduction purposes, it is possible that lighting impacts to nesting females and emerging hatchlings from adjacent lighting sources (streets, parking lots, hotels, etc) may become more problematic as shading from dunes, vegetation, etc. is not longer evident (Brock, 2005; Ehrhart and Roberts, 2001). In a study on Brevard county beaches, Brock (2005) found that loggerhead hatchling disorientations increased significantly post-nourishment. This was attributed to the increase in light sources not previously visible to be seen by hatchlings as a result of the increase in profile elevation combined with an easterly expansion of the beach. However, a dune feature will be constructed as a component of this project and is, therefore, expected to reduce lighting impacts to nesting and hatchling sea turtles that are associated with raising the beach elevation.

If beach construction activities extend into the sea turtle nesting and hatching season, all lighting associated with project construction will be minimized to the maximum extent practicable while maintaining compliance with all Corps, U.S. Coast Guard, and OSHA safety requirements. Direct lighting of the beach and near shore waters will be limited the immediate construction area(s). Lighting aboard dredges and associated vessels, barges, etc. operating near the sea turtle nesting beach shall be limited to the minimal lighting necessary to comply with the Corps, U.S. Coast Guard, and OSHA requirements. Lighting on offshore or onshore equipment will be minimized through reduced wattage, shielding, lowering, and/or use of low pressure sodium lights, in order to reduce illumination of adjacent beach and nearshore waters will be used to the extent practicable.

The use of sea turtle friendly lighting has been shown to significantly improve beaches for sea turtle nesting. Therefore, in conjunction with the proposed beach project, local lighting ordinances will be encouraged to the maximum extent practicable in order to reduce lighting impacts to nesting females and hatchlings. The local sponsors will be encouraged to work with the USFWS, local monitoring groups, and other concerned organizations to develop the best plan for the Towns of Surf City and North Topsail Beach.

(2) Dredging Impacts.

a. Food Supply.

After leaving the nesting beach, hatchling green and loggerhead turtles head towards the open ocean pelagic habitats (Carr, 1987) where their diet is mostly omnivorous with a strong carnivorous tendency in green turtles (Bjorndal, 1985). At about 20-25 cm carapace length Atlantic green turtles enter benthic foraging areas and shift to an herbivorous diet, feeding predominantly on sea grasses and algae but may also feed over coral reefs and rocky bottoms (Mortimer, 1982). At about 40 to 50 cm carapace length, loggerheads move into shallow water where they forage over benthic hard and soft bottom habitats (Carr, 1986). Loggerhead sea turtles feed on benthic invertebrates including mollusks, crustaceans, and sponges (Mortimer, 1982) but have also been found to eat fish, clams, oysters, sponges, jellyfish, shrimp, and crabs when near shore. Hawksbill and Kemp's ridley sea turtles are carnivorous (Mortimer, 1995) with a principal food source of crustaceans, mollusks, other invertebrates, and fish (Schwartz, 1977). Hawksbills feed on encrusting organisms such as sponges, tunicates, bryozoans, mollusks, and algae; whereas Kemp's ridleys feed predominantly on portunid crabs (Bjomdal, 1985). Leatherback sea turtles are carnivorous (Mortimer, 1995) and feed primarily on cnidarians and tunicates (salps, pyrosomas) throughout the water column but are commonly observed feeding at the surface (Bjorndal, 1985).

Dredging will be performed within offshore borrow areas located approximately 1 to 6 miles offshore and will not affect these resources in the inshore environment. Impacts on benthic habitat at the offshore borrow sites will be minor as dredging will only affect a limited portion of the offshore benthic habitat. Hardbottom surveys and subsequent mapping were performed within all proposed borrow sites and diver ground truth surveys were performed to characterize select sites. Dredging buffers of 400 ft for low relief and 500 m for moderate and high relief hard bottom systems will be adhered to in order to avoid impacts to hard bottom associated foraging habitat. Impacts to sandy bottom foraging habitat are expected to be isolated and short term in duration. Therefore, the project should not significantly affect the food supply of benthic foraging sea turtles in the offshore borrow sites. Considering that leatherbacks feed primarily within the water column on non-benthic organisms, the project should not significantly affect the food supply of this species

b. Relationship to Critical Periods in Life Cycle.

Sea turtles migrate within North Carolina waters throughout the year, mostly between April and December. The dredging of sediment from designated borrow sites during initial construction and each nourishment interval will be performed using a hopper dredge. Hopper dredges potentially pose the greatest risk to benthic oriented sea turtles through physical injury or death by entrainment as the hopper dredge dragheads remove sediment from sea bottom.

In order to minimize potential impacts, hopper dredges will be used from 1 December to 31 March of any year when water temperatures are cooler and sea turtle abundance is low, generally <14°C (57.2°F). However, because some sea turtle species may be found year-round in the offshore area, hopper-dredging activities may occur during low levels of sea turtle migration. Therefore, the proposed hopper dredging activities may adversely effect loggerhead, green, hawksbill, and Kemp's ridley sea turtles. Based on historic hopper dredging take data, leatherback sea turtles are not known to be impacted by hopper dredging operations. The Corps will abide by the provisions of the September 25, 1997 Regional Biological Opinion for The Continued Hopper Dredging Of Channels And Borrow Areas In The Southeastern United States or any superseding RBO provided by NMFS. To reduce impacts, the Corps anticipates taking certain precautions as prescribed by NMFS and USACE under standard hopper dredging protocol and will maintain observers on hopper dredges for the periods prescribed by NMFS to document any takes of turtle species and to ensure that turtle deflector dragheads are used properly.

(3) Summary Effect Determination.

All five species are known to occur within oceanic waters of the proposed project borrow areas; however, only the loggerhead, green, and leatherback sea turtles are known to nest within the limits of the project beach placement area. Therefore, species specific impacts may occur from both the beach placement and dredging operations. Considering the proposed dredging window to avoid the sea turtle nesting season to the maximum extent practicable, the proposed project may affect but is not likely to adversely affect nesting loggerhead, green, and leatherback sea turtles by altering nesting habitat. Though significant alterations in beach substrate properties may occur with the input of sediment types from other sources, re-establishment of a berm and dune system with a gradual slope can enhance nesting success of sea turtles by expanding the available nesting habitat beyond erosion and inundation prone areas. As previously stated, in regards to suitability for nesting, turtles continue to nest on disposal beaches of Topsail Island with hatch rate successes similar to non-disposal beaches (Jean Beasley, pers. comm.).

The proposed hopper dredging activities for initial construction, as well as each nourishment interval, may occur in areas used by migrating turtles. Hopper dredges pose risk to benthic oriented sea turtles through physical injury or death by entrainment. Though the 1 December to 31 March dredging window will avoid periods of peak turtle abundance during the warm water months, the risk of lethal impacts still exist as some sea turtle species may be found year-round in the offshore area. Therefore, the proposed hopper dredging activities may adversely affect loggerhead, green, hawksbill, and Kemp's ridley sea turtles. Based on historic hopper dredging take data, leatherback sea turtles are not known to be impacted by hopper dredging operations.

3.02.6 Shortnose Sturgeon

Detailed life history information associated with the the life cycle requirements for shortnose sturgeon and a subsequent analysis of impacts from the proposed dredging activities are provided within the following Section 7 consultation documents:

National Marine Fisheries Service. 1997. Regional Biological Opinion for the Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland

USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE, Wilmington District. Submitted to NMFS on 12 September 2008

A summary of project specific information and associated impacts is provided in the ensuing text.

a. Status. Endangered

b. Occurrence in Immediate Project Vicinity. Populations of shortnose sturgeon range along the Atlantic seaboard from the Saint John River in New Brunswick, Canada to the Saint Johns River, Florida (USFWS, 1999b). It is apparent from historical accounts that this species may have once been fairly abundant throughout North Carolina's waters; however, many of these early records are unreliable due to confusion between this species and the Atlantic sturgeon (*Acipenser oxyrhynchus*). There are historical records of the shortnose sturgeon both in Albemarle Sound and the nearshore ocean (Dadswell, *et al*., 1984). However, in the recent past, this species was thought to be extirpated from North Carolina (Schwartz, *et al*., 1977). During the winter of 1986-87, the shortnose sturgeon was taken from the Brunswick River, a component of the Cape Fear River basin. With this discovery, the species is once again considered to be a part of the state's fauna; however, there are still no recent records of the species within the New River inlet vicinity of the project area (F. Rhode 2008, pers. comm.). Because of the lack of suitable freshwater spawning areas in the project area and the requirement of low salinity waters by juveniles, any shortnose sturgeons present would most likely be non-spawning adults (NMFS, 1998).

c. Current Threats to Continued Use of the Area. Pollution, blockage of traditional spawning grounds, and over fishing are generally considered to be the principal causes of the decline of this species. The prohibition by North Carolina Division of Marine Fisheries (NCDMF) on taking any sturgeon in North Carolina should help to protect the species from commercial and recreational fishing pressure.

d. Project Impacts.

(1) Habitat.

The shortnose sturgeon is principally a riverine species and is known to use three distinct portions of river systems: (1) non-tidal freshwater areas for spawning and occasional over wintering; (2) tidal areas in the vicinity of the fresh/saltwater mixing zone, year-round as juveniles and during the summer months as adults; and (3) high salinity estuarine areas (15 parts per thousand (ppt.) salinity or greater) as adults during the winter. Habitat conditions suitable for juvenile and adult shortnose sturgeon could occur within the project area; however, spawning habitat should lie well outside of the project area and should not be affected by this project. The presence of juvenile shortnose sturgeon is not likely due to high salinity. Adults are found in shallow to deep water (6 to 30 feet) and, if present, would be expected to occupy the deeper channels during the day and the shallower areas adjacent to the channel during the night (Dadswell *et al*., 1984).

(2) <u>Food Supply</u>.

The shortnose sturgeon is a bottom feeder, consuming various invertebrates and stems and leaves of macrophytes. Adult foraging activities normally occur at night in shallow water areas adjacent to the deep-water areas occupied during the day. Juveniles are not known to leave deep-water areas and are expected to feed there.

Dredging for this project will occur at borrow sites located between 1-6 miles offshore; therefore, shallow water feeding areas will not be affected by the project.

(3) <u>Effect Determination</u>.

Although hopper dredges have been known to impact shortnose sturgeons, dredging for this project will occur in offshore environments, outside of its habitat range. Therefore, impacts from dredges are not anticipated to occur. Because of the unlikelihood of shortnose sturgeon being present in the project area (Fritz Rhode 2008, pers.comm.) and since dredging will occur in the offshore environment, it has been determined that the actions of the proposed project are not likely to adversely affect the shortnose sturgeon.

3.02.7 Seabeach Amaranth

a. <u>Status</u>. Threatened

b. <u>Occurrence in Immediate Project Vicinity</u>. Seabeach amaranth is an annual or sometimes perennial plant that usually grows between the seaward toe of the dune and the limit of the wave uprush zone occupying elevations ranging from 0.2 to 1.5 m above mean high tide (Weakly and Bucher, 1992). Greatest concentrations of seabeach amaranth occur near inlet areas of barrier islands, but in favorable years many plants may occur away from inlet areas. It is considered a pioneer species of accreting shorelines, stable foredune areas, and overwash fans (Weakly and Bucher, 1992; Hancock and Hosier, 2003). Seed dispersal of seabeach amaranth is achieved in a number of ways, including water and wind dispersal (USFWS, 1995).

Historically, seabeach amaranth was found from Massachusetts to South Carolina, but according to recent surveys (USACE 1992-2004), its distribution is now restricted to North and South Carolina with several populations on Long Island, New York. The decline of this species is caused mainly by development of its habitat, such as inlet areas and barrier islands, and increased ORV and human traffic, which tramples individual plants (Fussell, 1996).

Seabeach amaranth surveys have been performed on the northern 3.8 miles of North Topsail Beach since 1992; however, surveys were not conducted along the southern limits of North Topsail Beach (~8.0 miles) or Surf City (~5.5) miles) until 2006. Based on the available data, a total of 24,369 plants have been recorded throughout the towns of North Topsail Beach and Surf City for all years surveyed (Table 4). Hurricanes, long term shoreline erosion, and subsequent habitat loss, have likely played a role in the reduction in plant numbers on North Topsail Beach from 2001-2008.

Table 4. Annual seabeach amaranth survey results (1992-2008) at North Topsail Beach and Surf City, NC.

County	Beach Name	Sub-Part (Reach)	TOTAL AMARANTHUS PLANT COUNT BY YEAR																	Total All Yrs
			1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Onslow	North Topsail Beach	A	247	231	925	819	578	1	548	32	117	1,344	433	493	248	381	1	18	68	6,484
Onslow	" "	B	237	72	375	96	142	0	1,300	57	^ ^ ^	590	188	117	12	5	3	5	18	3,217
Onslow	" "	C	939	821	293	10,214	1,068	21	758	29	^ ^ ^	173	2	33	4	0	0	0	3	14,358
Onslow	" "	D	1	0	0	0	0	0	36	5	^ ^ ^	0	0	0	0	0	1	0	0	43
Onslow	" "	A1															0	63	66	129
Onslow	" "	A2															5	8	66	79
Onslow	" "	A3															3	37	11	51
Pender	Surf City	A															0	0	4	4
Pender		B															0	0	4	4
Pender		C															0	0	0	0
NOTES:			1,424	1,124	1,593	11,129	1,788	22	2,642	123	117	2,107	623	643	264	386	13	131	240	24,369

	= Not surveyed
^ ^ ^	= Count combined in reach above
	= Year of hurricane impact
	= Count exceeding 1,000 Amaranthus
	= New Reach 2006

Since sea beach amaranth seeds are fairly resilient and germination is dependent on critical physical conditions, populations of seabeach amaranth are very dynamic with numbers of plants fluctuating dramatically from year to year. Germination begins in April as temperatures reach about 25ºC (77ºF) and continues at least through July with greatest germination occurring at 35ºC (95ºF) (USFWS, 1996b; Hancock and Hosier, 2003). Seed production begins in July or August, peaks in September, and continues until the plant dies (USFWS, 1996b). According to Hancock and Hosier (2003) sea beach amaranth is physically controlled (salt water inundation, temperature, emergence at depth, etc.) rather than biologically controlled (web worm). Furthermore, seedlings are unable to emerge from depths greater than 1cm; however, seabeach amaranth seeds are resilient, and century–old seeds of some species of amaranth are capable of successful germination and growth (USFWS, 1996b).

c. Current Threats to Continued Occurrence in the Project Area.

Seabeach amaranth has been eliminated from approximately two-thirds of its historic range. Habitat loss and degradation are the greatest threats to the continued existence of seabeach amaranth with localized herbivory by webworms also contributing to mortality in North Carolina. Though beach stabilization efforts are thought to be a leading contributor to the decrease in the population (USFWS, 1996b), new populations have been observed to follow sand placement on beaches where sand has been disposed by the Corps of Engineers (ex. Wrightsville Beach and Bogue Banks) (USFWS, 1996b; CSE, 2004). Seabeach amaranth is dependent on terrestrial, upper beach habitat that is not flooded during the growing season from May in to the fall. Therefore, beach erosion is probably the primary threat to the continued presence in the area. Furthermore, beach bulldozing is common practice on Topsail Beach and in many cases may add to the existing erosion problem and loss of seabeach amaranth habitat.

d. Project Impacts.

(1) Habitat.

The berm and dune project extends along a reach of 52,150 feet. On the north end, the project will adjoin an adjacent non-Federal beachfill project for North Topsail Beach. The proposed project limits avoids the northern portion of North Topsail Beach where historic survey data indicate amaranth most commonly occurs. The beachfront within the project limits is currently conducive to the growth of seabeach amaranth; however, due to high erosion rates and inundation from storm events its available habitat is deteriorating. Beach nourishment would have initial impacts through burial of existing plants and seeds; however, much of the habitat requirements for seabeach amaranth lost to erosion will be restored.

(2) Relationship to Critical Periods in Life Cycle.

Beach nourishment will be conducted outside of the germination and growing period. Initial construction and each nourishment event will be performed using a hopper dredge from 1 December through 31 March. If dredging takes place in the winter when only seabeach amaranth seeds are present, the direct impacts on individual plants will be avoided; however, burying seeds during any season could effect the population. While such construction is not an ideal management practice for the species, the restoration of the habitat is of prime importance. Beach nourishment rebuilds habitat for seabeach amaranth and can have long-term benefits (USFWS, 1996b). The project area would be included in the USACE seabeach amaranth monitoring program during the summertime growing season for the life of the beachfill.

(3) Effect Determination. Beach nourishment will restore much of the existing habitat lost to erosion and is expected to provide long-term benefits to seabeach amaranth; however, construction and deep burial of seeds on a portion of the beaches during project construction may slow germination and population recovery over the short-term. Therefore, the project may affect, but is not likely to adversely affect seabeach amaranth.

3.02.8 Piping Plover

a. Status. Threatened

b. Occurrence in Immediate Project Vicinity: The Atlantic Coast piping plover population breeds on coastal beaches from Newfoundland to North Carolina (and occasionally in South Carolina) and winters along the Atlantic Coast (from North Carolina south), the Gulf Coast, and in the Caribbean where they spend a majority of their time foraging. Since being listed as threatened in 1986, only 800 pairs were known to exist in the three major populations combined and by 1995 the number of detected breeding pairs increased to 1,350. This population increase can most likely be attributed to increased survey efforts and implementation of recovery plans (Mitchell *et. al*., 2000).

Piping plovers are known to nest in low numbers in widely scattered localities on North Carolina's beaches. The species typically nests in sand depressions on unvegetated portions of the beach above the high tide line on sand flats at the ends of sand spits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, sparsely vegetated dunes, and washover areas cut into or between dunes. Piping plovers head to their breeding grounds in late March or early April (http://pipingplover.fws.gov/overview.html) and nesting usually begins in late April; however, nests have been found as late as July (Potter, *et al*., 1980; Golder, 1985). During a statewide survey conducted in 1988, 40 breeding pairs of piping plovers were located in North Carolina. LeGrand (1984a) states that "all of the pipings in the state nest on natural beachfronts, both completely away from human habitation and [yet] in moderate proximity to man". The largest reported nesting concentration of the species in the State appears to be on Portsmouth Island where 19 nests were discovered in 1983 by John Fussell (LeGrand, 1983). The southernmost nesting record for the state was one nest located in Sunset Beach by Phillip Crutchfield in 1983 (LeGrand, 1984b). Feeding areas include intertidal portions of ocean beaches, washover areas, mud flats, sand flats, wrack lines, and shorelines of coastal ponds, lagoons, or salt marshes (USFWS, 1996a). Prey consist of worms, fly larvae, beetles, crustaceans, mollusks, and other invertebrates (Bent, 1928).

The piping plover is a fairly common winter resident along the beaches of North Carolina (Potter *et al*., 1980). On 10 July 2001, the USFWS designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for the wintering population of the piping plover where they spend up to 10 months of each year on the wintering grounds. Constituent elements for the piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The USFWS has defined textual unit descriptions to designate areas within the critical habitat boundary. These units describe the geography of the area using reference points, include the areas from the landward boundaries to the MLLW, and may describe other areas within the unit that are utilized by the piping plover and contain the primary constituent elements. Though no units are designated within the immediate project area, unit NC-11 is designated at the southern end of Topsail Beach on Topsail Island. Unit NC-11 encompasses approximately 1114 acres in Pender and New Hanover counties extending southwest from 1.0 km northeast of MLLW of New Topsail Inlet on Topsail Island to 0.53 km southwest of MLLW of Rich Inlet on Figure Eight Island. This unit includes Topsail Inlet and associated lands including emergent sandbars, from MLLW on Atlantic Ocean and sound side to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur. In Topsail Sound, the unit stops as the entrance to tidal creeks become narrow and channelized (Federal Register/Vol. 66, No 132, July 10, 2001).

Most piping plovers on Topsail Island have been observed as predominantly migratory and winter residents utilizing intertidal flats exposed at low tide for feeding and roosting; however, two breeding pairs have been observed on North Topsail Beach (Table 5). Based on survey data conducted since 1989 (annual nesting habitat surveys, coast-wide wintering surveys, and opportunistic surveys) a total of 11 piping plovers have been identified within the project vicinity.

Table 5. Piping plover observations based on nesting habitat annual surveys conducted since 1989, coast-wide wintering surveys conducted on select years (most recently in 1996, 2001, and 2006), and opportunistic surveys.

Location	Survey Date	Season	Number of Birds	Number of Breeding Pairs
North Topsail Beach - New River Inlet	7/1/1992	Breeding	2	1
North Topsail Beach	7/1/1993	Breeding	2	1
North Topsail Beach - New River Inlet	4/30/2000	Spring Migration	2	NA
North Topsail Beach	10/18/2000	Fall Migration	1	0
North Topsail Beach - New River Inlet	9/8/2001	Fall Migration	1	0
North Topsail Beach	9/2/2004	Fall Migration	2	NA
North Topsail Beach - New River Inlet	8/26/2008	Fall Migration	1	NA

c. Current Threats to Continued Use of the Area. Loss and degradation of habitat due to development and shoreline stabilization have been major contributors to the decline of piping plovers. The current commercial, residential, and recreational development has decreased the amount of coastal habitat available for piping plovers to nest, roost, and feed. Specifically on

North Topsail Beach, nesting habitat continues to be degraded. Washover habitat that was created after Hurricane Fran in 1996 has since been developed with residential homes resulting in a continued decrease in nesting habitat availability. Additionally, nesting habitat along the northern end of North Topsail beach, adjacent to New River Inlet, continues to be eroded away as result of the recent southwesterly shift of New River Inlet and the subsequent erosion towards the residential structures. Furthermore, long and short-term coastal erosion and the abundance of predators, including wild and domestic animals as well as feral cats, have further diminished the potential for successful nesting of this species. Since project beaches are wintering area for the piping plover, the major threat to its occupation of the area during the winter months would be continued degradation of beach foraging habitat. Similar degradation of beaches elsewhere could be a contributing element to declines in the state's nesting population.

d. Project Impacts.

(1) Habitat. The existing shorelines of Surf City and North Topsail Beaches are heavily developed and are experiencing significant shoreline erosion. Piping plover breeding territories on the Atlantic Coast typically include a feeding area along expansive sand or mudflats in close proximity to a sandy beach that is slightly elevated and sparsely vegetated for roosting and nesting (http://nc-es.fws.gov/birds/pipiplov.html). As erosion and development persist, piping plover breeding, nesting, roosting, and foraging habitat loss continues. Habitat loss from development and shoreline erosion and heavy public use has led to the degradation of piping plover habitat in the project area. The enhancement of beach habitat through the addition of beach fill may potentially restore lost roosting and nesting habitat; however, short-term impacts to foraging and roosting habitat may occur during project construction.

Initial construction and each periodic nourishment cycle will be performed using a hopper dredge and will adhere to a 1 December to 31 March dredging window. Since piping plovers head to their breeding grounds in late March and nesting occurs in late April, project initial construction and nourishment events will avoid impacts to breeding and nesting piping plovers to the maximum extent practicable. Additionally, the project construction limits do not extend into the high valued habitat located adjacent to New River Inlet at the North end of North Topsail Beach and will therefore avoid this documented nesting habitat. However, wintering habitat for roosting and foraging may be impacted. Direct short-term foraging habitat losses will occur during construction of the project fill. Since only a small portion of the foraging habitat is directly affected at any point in time during pumpout and adjacent habitat is still available, overall direct loss of foraging habitat will be minimal and short-term. Additionally, complete initial project construction template will be completed in four sections; therefore, un-impacted or recovered foraging habitat will be available throughout the duration of the initial construction period.

The selected plan consists of a sand dune constructed to an elevation of 15 feet above NGVD fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD. Piping plover nesting habitat includes blowout areas behind primary dunes as well as washover areas cut into or between dunes. The size and shape of the constructed dune may minimize the frequency of sand washover areas and subsequent nesting habitat availability. However, the project area is heavily developed already and based on the post-storm development response evidenced by Hurricane Fran, the washover fans created by large storm events are quickly re-developed by land owners. Due to the current development practices within the project area, the formation of these washover features will not be sustained in a similar fashion to undeveloped barrier islands; rather, it is anticipated that, without the proposed project, these washover features would be located on private (private residences) or state (NC Department of Transportation) owned property and would be cleared or built upon in order to re-establish the community to the pre-storm condition. Existing undeveloped habitat located adjacent to New River Inlet will not be impacted by the project.

(2) Food Supply. Piping plovers feed along beaches and intertidal mud and sand flats. Primary prey includes polychaete worms, crustaceans, insects, and bivalves. According to Section 8.01.6 of the EIS, the benthic invertebrate community will suffer short-term impacts from the placement of sediment on the beach; thus, a diminished prey base will subsequently impact piping plovers over the short term. However, only a portion of the beach is affected at any point in time (approximately 4-5,000 feet per month). Once construction passes that point, recruitment from adjacent beaches can begin. Therefore, un-impacted or recovering foraging habitat on Surf City and North Topsail beaches will be available throughout the duration of the project.

(3) Relationship to Critical Periods in Life Cycle. Beach placement of sand derived from identified borrow sites is expected to occur from 1 December to 31 March during initial construction and each periodic nourishment interval. Therefore, the breeding and nesting season will be avoided. However, foraging, sheltering, and roosting habitat may be temporarily impacted.

(4) Effect Determination. The long-term effects of the project may restore lost roosting and nesting habitat through the addition of beach fill; however, short-term impacts to foraging, sheltering, roosting habitat may occur during project construction. Therefore, it has been determined that the project may affect, but is not likely to adversely affect the piping plover.

3.02.9 Smalltooth Sawfish

Detailed life history information associated with the life cycle requirements for smalltooth sawfish and a subsequent analysis of impacts from the proposed dredging activities are provided within the following Section 7 consultation document:

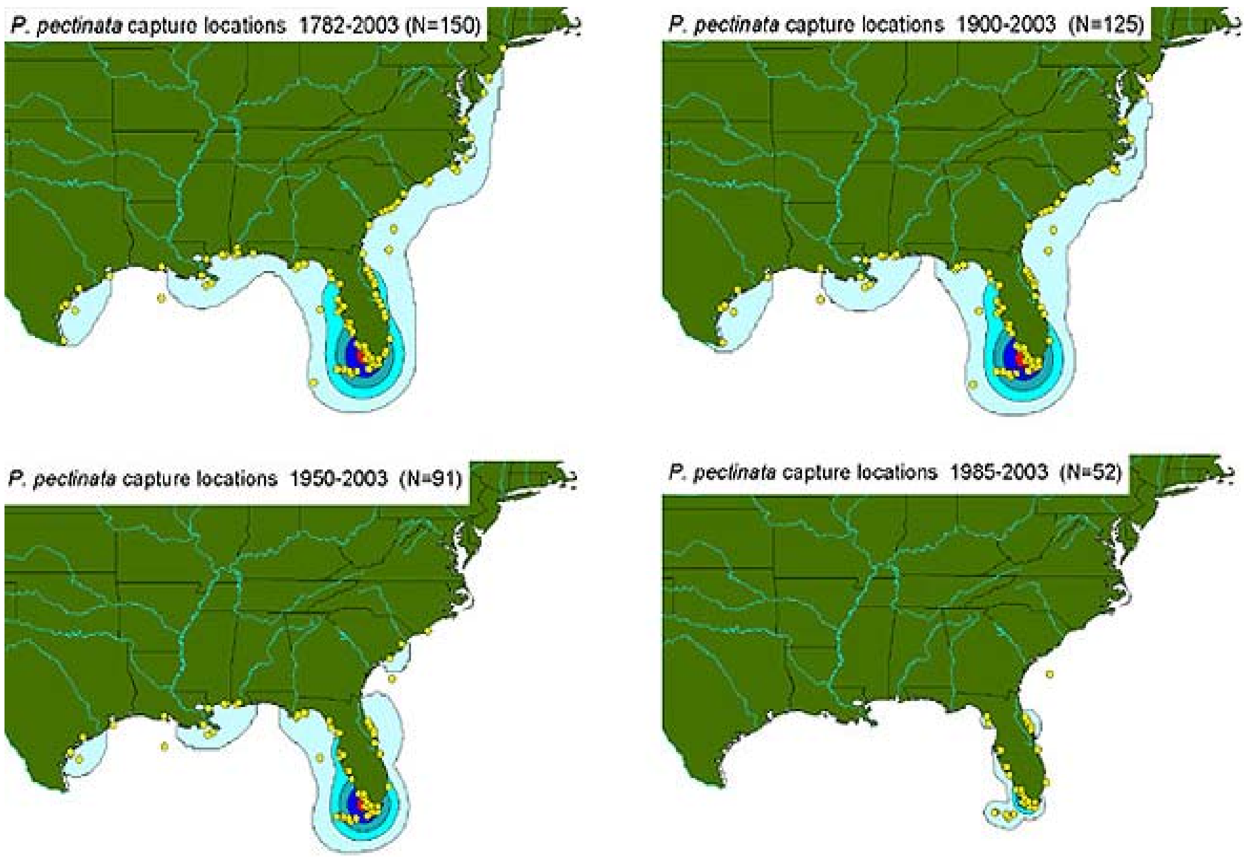
USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE,Wilmington District. Submitted to NMFS on 12 September 2008

A summary of project specific information and associated impacts is provided in the ensuing text.

a. Status. Endangered. The U.S. smalltooth sawfish distinct population segment (DPS) was listed as endangered under the ESA on April 1, 2003 (68 FR 15674) and is the first marine fish to be listed in the United States.

b. Occurrence in Immediate Project Vicinity. Historic records suggest that during the 19th century the smalltooth sawfish was a common resident of the Atlantic and Gulf coastal waters of the southeastern United States. Throughout the 20th century it was recorded with declining frequency and today it can be no longer considered a functional member of the nearshore coastal community of the northwest Atlantic. Historic records indicate that the smalltooth sawfish abundantly occurred in the mid-Atlantic region only during the summer months (Adams and Wilson, 1995). The smalltooth sawfish range has subsequently contracted to peninsular Florida and, within that area, can only be found with any regularity off the extreme southern portion of the state between the Caloosahatchee River and the Florida Keys (Figure 2). Smalltooth sawfish are most common within the boundaries of the National Everglades National Park and the Florida Keys, and become less common with increasing distance from this area (Simpfendorfer, 2002).

Figure 2. Historic and Current Distribution of Smalltooth Sawfish in the U.S. (Burgess *et al.,* 2003).



c. Current Threats to Continued Use of the Area. The principal habitats for smalltooth sawfish in the southeast U.S. are the shallow coastal areas and estuaries, with some specimens moving upriver in freshwater (Bigelow and Schroeder, 1953). The continued urbanization of the southeastern coastal states has resulted in substantial loss of coastal habitat through such activities as agricultural and urban development; commercial activities; dredge and fill operations; boating; erosion and diversions of freshwater run-off (SAFMC, 1998). Smalltooth sawfish may be especially vulnerable to coastal habitat degradation due to their affinity to shallow, estuarine systems. Smalltooth sawfish have historically been caught as by-catch in various fishing gears throughout their historic range, including gillnet, otter trawl, trammel net, seine, and to a lesser degree, hand line. Today, they are occasionally incidentally caught in commercial shrimp

trawls, bottom longlines, and by recreational rod-and-reel gear. With the K-selected life history strategy of smalltooth sawfish, including slow growth, late maturation, and low fecundity, long-term commitments to habitat protection are necessary for the eventual recovery of the species.
A complete review of the factors contributing to the decline of the smalltooth sawfish can be found in the "Status Review of Smalltooth Sawfish (*Pristis pectinata*)", (NMFS, 2000). The Draft Recovery plan for smalltooth sawfish (NMFS, 2006) also presents a detailed threats assessment with four major categories of threats: 1) Pollution; 2) Habitat degradation or loss; 3) Direct injury and 4) Fisheries Interactions. Neither of these discussions will be repeated in detail in this assessment, but are incorporated herein by reference.

d. Project Impacts. As identified in the August 2006 Draft Smalltooth Sawfish Recovery Plan, "habitat effects of dredging include the loss of submerged habitats by disposal of excavated materials, turbidity and siltation effects, contaminant release, alteration of hydrodynamic regimes, and fragmentation of physical habitats (SAFMC, 1998). Cumulatively, these effects have degraded habitat areas for smalltooth sawfish." The current range of sawfish has contracted to peninsular Florida and can only be found with any regularity off the extreme southern portion of the state. Smalltooth sawfish occur in shallow estuarine environments and juvenile sawfish are particularly dependent on mangrove habitat.

In the GRBO issued by NMFS on November 19, 2003 (as amended in 2005 and 2007), in the section entitled "Species Not Likely to Be Affected," NMFS concludes the following: "Smalltooth sawfish (*Pristis pectinata*) are tropical marine and estuarine fish that have the northwestern terminus of their Atlantic range in the waters of the eastern U.S. Currently, their distribution has contracted to peninsular Florida and, within that area, they can only be found with any regularity off the extreme southern portion of the state. The current distribution is centered in the Everglades National Park, including Florida Bay. They have been historically caught as by-catch in commercial and recreational fisheries throughout their historic range; however, such by-catch is now rare due to population declines and population extirpations. Between 1990 and 1999, only four documented takes of smalltooth sawfish occurred in shrimp trawls in Florida (Simpfendorfer, 2000). After consultation with individuals with many years in the business of providing qualified observers to the hopper dredge industry to monitor incoming dredged material for endangered species remains (C. Slay, Coastwise Consulting, pers. comm. August 18, 2003) and a review of the available scientific literature, NOAA Fisheries determined that there has never been a reported take of a smalltooth sawfish by a hopper dredge, and such take is unlikely to occur because of smalltooth sawfishes affinity for shallow, estuarine systems."

(e) Effect Determination. Based on the current South Atlantic distribution of smalltooth sawfish and only one sighting in North Carolina since 1999, hopper dredge impacts to smalltooth sawfish within the project area are unlikely. Additionally, the take of a smalltooth sawfish by a hopper dredge is unlikely considering the smalltooth sawfishes affinity for shallow, estuarine systems as well as the fact that there has never been a reported take of a smalltooth sawfish by a hopper dredge. Therefore, hopper dredge activities associated with this project are not likely to adversely affect smalltooth sawfish.

4.00 COMMITMENTS TO REDUCE IMPACTS TO LISTED SPECIES

The following is a summary of environmental commitments to protect listed species related to the construction and maintenance of the proposed project. These commitments address agreements with resource agencies, mitigation measures, and construction practices:

1. The Corps will strictly adhere to all conditions outlined in the most current National Marine Fisheries Service RBO for dredging of channels and borrow areas in the southeastern United States. Furthermore, as a component of this project, hopper dredging activities for both initial construction and each nourishment interval will adhere, to the maximum extent practicable, to a dredging window of 1 December to 31 March in order to avoid periods of peak sea turtle abundance. The use of turtle deflecting dragheads, inflow and/or overflow screening, and NMFS certified turtle and whale observers will also be implemented.

2. In order to determine the potential taking of whales, turtles and other species by hopper dredges, NMFS certified observers will be on board during all hopper dredging activities. Recording and reporting procedures will be in accordance with the conditions of the current NMFS RBO.

3. Endangered species observers (ESOs) will be on board all hopper dredges and will record all large whale sightings and note any potential behavioral impacts. The Corps and the Contractor will keep the date, time, and approximate location of all marine mammal sightings. Care will be taken not to closely approach (within 300 feet) any whales, manatees, or other marine mammals during dredging operations or transportation of dredged material. An observer will serve as a lookout to alert the dredge operator and/or vessel pilot of the occurrence of these animals. If any marine mammals are observed during other dredging operations, including vessel movements and transit to the dredged material disposal site, collisions shall be avoided either through reduced vessel speed, course alteration, or both.

4. The Corps will avoid the sea turtle nesting season during initial construction and each nourishment interval. If, due to unforeseen circumstances, construction extends into the nesting season, the Corps will implement a sea turtle nest monitoring and avoidance/relocation plan through coordination with USFWS and NCWRC.

5. Monitoring of sea turtle nesting activities in beach nourishment areas will be required to assess post nourishment nesting activity. This will include daily surveys beginning at sunrise from May 1 until September 15. Information on false crawl location, nest location, and hatching success of all nests will be recorded and provided to NCWRC.

6. The beach will be monitored for escarpment formation by the Contractor prior to completion of beach construction activities associated with initial construction and each nourishment interval. Additionally, the beach will be monitored by the local sponsor for escarpment formation prior to each turtle nesting season every year between nourishment events. Escarpments which exceed 18 inches in height for a distance of 100 ft. will be leveled by the Contractor or local sponsor accordingly. If it is determined that escarpment leveling is required during the nesting or hatching season, leveling actions should be directed by the USFWS

7. Only beach compatible sediment will be placed on the beach as a component of this project. Post nourishment beach compaction (hardness) will be evaluated by the Corps, in coordination with the NCWRC and USFWS, using qualitative assessment techniques to assure that impacts to nesting and incubating sea turtles are minimized and, if necessary, identify appropriate mitigation responses.

8. Local lighting ordinances will be encouraged to the maximum extent practicable in order to reduce lighting impacts to nesting females and hatchlings. The local sponsors will be encouraged to work with the USFWS, local monitoring groups, and other concerned organizations to develop the best plan for the Towns of Surf City and North Topsail Beach.

9. Throughout the duration of each nourishment event, both initial construction and periodic nourishment, the Contractor will be required to monitor for the presence of stranded sea turtles, live or dead. If a stranded sea turtle is identified, the Contractor will immediately notify the NCWRC of the stranding and implement the appropriate measures, as directed by the NCWRC. Construction activities will be modified appropriately as not to interfere with stranded animals, live or dead.

10. In order to better understand the threshold of sediment color change and resultant heat conduction from nourishment on temperature dependent sex determination of sea turtles, the Corps will monitor nest temperatures in the project area during the nesting season following initial construction. This data will be compared to non-nourished native sediment temperatures in order to support development of management criteria for sediment color guidelines.

11. In order to assess the abundance of sea turtles, and potential risk of hopper dredge take, within the proposed borrow areas for this project, the Corps will participate in the NCWRC's current satellite telemetry efforts to track the distribution and habitat usage of sea turtles in NC offshore waters.

12. Monitoring for seabeach amaranth on Surf City and North Topsail Beaches will be implemented in the growing season following initial construction to assess the post nourishment presence of plants. This survey will broken down into survey reaches for each town in accordance with the designated USACE sea beach amaranth survey reaches from 1991-2008 in order to maintain consistent data and survey techniques over time and results will be provided to USFWS

13. The Corps will implement precautionary measures for avoiding impacts to manatees during construction activities as detailed in the "Guidelines for Avoiding Impacts to the West Indian Manatee in North Carolina Waters" established by the USFWS.

14. The Corps will adhere to appropriate environmental windows for piping plovers and other shorebirds to the maximum extent practicable.

15. All staging areas, pipeline routes, and associated construction activities will avoid high value piping plover and shorebird habitat, located within the vicinity of New River Inlet, to the maximum extent practicable.

5.00 SUMMARY EFFECT DETERMINATION

Threatened and endangered species summary effect determination for beach placement and dredging activities associated with the proposed project area (No Effect (NE – green); May Affect Not Likely to Adversely Affect (MANLAA – orange); and May Affect Likely to Adversely Affect (MALAA – red).

Listed Species w/in the Project Area		Effect Determination	
		Beach Placement Activities (USFWS)	In-Water Dredging Activities (NMFS)
Sea Turtles	*Leatherback*	MANLAA	MANLAA
	Loggerhead	MANLAA	MALAA
	Green	MANLAA	MALAA
	Kemp's Ridley	NE	MALAA
	Hawksbill	NE	MALAA
Large Whales	*Blue, Finback, Sei, and Sperm*	NE	NE
	NARW	NE	MANLAA
	Humpback	NE	MANLAA
West Indian Manatee		NE	MANLAA
American Alligator		NE	NE
Piping Plover		MANLAA	NE
Red-cockaded Woodpecker		NE	NE
Shortnose Sturgeon		NE	NE
Smalltooth Sawfish		NE	NE
Seabeach Amaranth		MANLAA	NE
Golden Sedge		NE	NE
Chaffseed		NE	NE
Cooley's Meadowrue		NE	NE
Rough-leaved Loosestrife		NE	NE

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