Action ID: SAW-2011-01241
Permittee: The Town of Ocean Isle Beach
Location: Ocean Isle Beach, Brunswick County, North Carolina
Date: February 27, 2017

RECORD OF DECISION (ROD)

1. **Introduction**

The Town of Ocean Isle Beach has applied for a Department of the Army (DA) permit pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. Provided below are my findings and decision regarding this permit application.

After consideration of the costs, benefits and environmental consequences of the proposed and alternative actions, the Town is proposing a shore protection project including the construction of a 750 foot terminal groin located approximately 148 feet east of station 0+00. Construction of the 750 linear feet terminal groin structure, which includes a 300 linear foot anchorage system, would involve the permanent discharge of fill material into approximately 1.37 acres of waters of the United States below Mean High Water and 3,214 linear feet (lf) of dry beach front. The 3,214 foot section of shoreline located directly west of the terminal groin would be pre-filled with approximately 264,000 cubic yards of material obtained from dredging Shallotte Inlet, the same source of material as the Coastal Storm Damage Reduction Project (CSDRP). The dredged material to be placed behind the terminal groin structure is referred to as a ‘fillet’ in this document. The currently authorized dredging area within Shallotte Inlet is approximately 17 acres, and is dredged to a depth of -18 ft. NAVD through the use of hydraulic dredge methodologies. The projected dredge and nourishment interval for this proposed project would be approximately every five years instead of three years as currently authorized for the CSDRP.

The structural design of the groin would include a 300-foot shore anchorage section constructed with either concrete or steel sheet piles that would begin at a point 450 feet landward of the baseline. The top elevation of the sheet pile will vary from +4.5 feet NAVD88 over the landward 130 feet and increase to +4.9 feet NAVD over the last 170 feet. The top of the landward most portion of the shore anchorage section would be below the existing ground level. The sheet pile would tie into a rubble mound section that would extend 750 feet seaward from the end of the shore anchorage section and terminate 600 feet seaward of the baseline. The rubble mound portion of the terminal groin would be constructed with loosely placed armor stone on top of a foundation mat or mattress and would have a crest elevation of +4.9 feet NAVD. The loose nature of the armor stone was designed as a “leaky structure” to facilitate the movement of littoral material through the structure, while the relative low crest elevation of +4.9 feet NAVD would allow some sediment to pass over the structure during periods of high tide. As required by the U.S. Coast Guard, this project also involves the installation of three signs in navigable waters to aid in navigation.

As the District Engineer for the Wilmington District, U. S Army Corps of Engineers, it is my decision, based on review of the Final Environmental Impact Statement, Town of Ocean Isle Beach Shoreline Protection Project dated April 2016 (FEIS) and the District's files on this matter, that the proposed project is permittable with the inclusion of permit special conditions. I find the applicant's proposed plan, as modified by the DA permit special conditions, to be permittable in light of my analysis of the available alternatives in relation to public interest review factors and the environment. These findings support my decision to authorize a Department of the Army permit pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act for the proposed project (i.e., Alternative 5).

2. Description of the Applicant's Proposed Project

The Applicant's proposed project, identified as Alternative 5 in the FEIS and this document, includes the construction of a terminal groin 750 ft. in length with a 300 ft. shore anchorage section to protect against possible flanking of the landward end of the structure. This structure is intended to control tidal current-induced shoreline changes immediately west of Shallotte Inlet. In addition to the construction of the terminal groin, a 3,214 ft. section of oceanfront shoreline adjacent to the structure would be nourished with material excavated from the borrow area utilized by the USACE in Shallotte Inlet.

The terminal groin structure would be constructed of large armor rock and would be underlain with a rock-filled marine mattress or composite filter fabric/geo-grid base. The armor stone would be limited to a uniform size ranging from 1 to 9 tons each, approximately 2' – 5.5' diameters. The structure would be constructed to a maximum elevation of +4.5' NGVD 29 to enhance permeability and allow for controlled down-drift sediment transport. The crest widths of the structure would vary between 6' and 15'. The side slopes of the structure would be constructed at a 2:1 slope and the width at the base of the structure would vary based on water depths.

Under Alternative 5, the applicant's preferred alternative, a 750-foot terminal groin with beach fill would be constructed 148 feet east of baseline station 0+00. This structure is intended to provide shoreline stabilization and would serve to reduce the erosion rate further west, reduce the nourishment interval of the federal project from approximately every 3 years to approximately every 5 years, and eliminate the necessity of placing sandbag revetments within the project area. Dredged material would be obtained from Shallotte Inlet within the limits of the borrow area used for the CSDRP. The initial fillet construction would be completed and maintained by the Town of Ocean Isle Beach.

The purpose of a terminal groin on the east end of Ocean Isle Beach would be to maintain the initial accretion fillet west of the structure in perpetuity. This would be accomplished by controlling tide induced or influenced sediment transport off the extreme east end of the island. The resulting position and alignment of the shoreline within the accretion fillet would mimic that of the shoreline immediately to the west. Once the accretion fillet is fully formed, wave driven sediment transport will move either through, over, or around the seaward end of the structure. The elimination or reduction in tide induced sediment transport off the extreme east end of the island should improve the performance and longevity of beach fill placed east of Shallotte

Boulevard as well as the performance of a portion of CSDRP that extends west of Shallotte Boulevard. The shoreline adjacent to the east and in proximity to the proposed terminal groin would, however, be relatively stabilized due to the protection afforded by the structure. The design objective for the terminal groin alternative was to minimize the combined cost associated with construction and maintenance of the terminal groin and nourishment of the Ocean Isle Beach west to USACE baseline station 120+00.

Chapter 5 of the Environmental Impact Statement summarizes both the negative and positive effects of Alternative 5, as well as all considered alternatives.

3. Purpose and Need

The applicant's purpose and need is identified in Chapter 2 of the FEIS and states that the purpose of the shoreline protection project is to mitigate chronic erosion on the eastern portion on the Town's oceanfront shoreline so as to preserve the integrity of its infrastructure, provide protection to existing development, and ensure the continued use of the oceanfront beach along this area.

The purpose and need of the Ocean Isle Beach Shoreline Management Project is as follows:

• To reduce or mitigate erosion along 3,500 feet of Ocean Isle Beach oceanfront shoreline west of Shallotte Inlet;

• To maintain the Town's tax base by providing long-term protection of property and infrastructure through reduced storm damage and erosion on the oceanfront shoreline of Ocean Isle Beach between Shallotte Inlet and the western terminus of the federal Project;

• Maintain existing recreational resources; and

• Balance the needs of the human environment with the protection of existing natural resources.

4. Public Coordination

In compliance with my responsibility under the National Environmental Policy Act (NEPA) of 1969, I have determined that the issuance of a permit pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act for the applicant's proposal (Alternative 5) to construct a terminal groin, dredge, and dispose of the dredged material behind the terminal groin structure would constitute a major federal action significantly affecting the quality of the human environment. An EIS was prepared in accordance with the requirements of NEPA (40 CFR Parts 1500 - 1508) and USACE regulations (33 CFR Part 325, Appendix B).

In a continual effort to include the public and all state and federal agencies in the review and scoping process, a Project Review Team (PRT) was assembled and included various entities including state and federal regulatory and resource agencies, non-profit environmental organizations, the applicant and their agents. The PRT approach allowed viewpoints from all perspectives to be addressed and allowed the preparation of a non-biased, all-inclusive EIS disclosure document. This team formally met on October 3, 2012, and March 5, 2013. A description of all meetings and a list of team members can be found in Appendix A (Scoping) of the FEIS. An official public scoping meeting was held on March 5, 2015 and a public hearing was held on March 3, 2015.

Through the NEPA review, all alternatives were subject to agency and public review and input. Our NEPA review included a public scoping meeting, public hearing on March 3, 2015, PRT meetings and the circulation of public notices on the Draft and Final EIS.

a. Draft Environmental Impact Statement

After a study of the project, review of public comments, and coordination with the members of the Project Review Team, the Corps prepared a Draft Environmental Impact Statement (DEIS). Preliminary drafts of both the DEIS and Final Environmental Impact Statement (FEIS) were prepared through a third-party contractor, Coastal Planning & Engineering of North Carolina, Inc., working under the direction and review of the Corps pursuant to 33 CFR §325, Appendix B, at para. 8(f). All published EIS documents were reviewed and edited by the Corps, and reflect the Corps' judgment. The DEIS was filed with the U.S. Environmental Protection Agency (EPA) and the document was released via federal Register Notice on January 23, 2015. The Corps simultaneously issued a public notice requesting comments on the proposed project, on the DEIS, and on the various alternatives described in that document. The Corps held a public hearing on the proposed project and the DEIS on March 3, 2015.

b. Final Environmental Impact Statement

The <u>Final Environmental Impact Statement for the Town of Ocean Isle Beach Shoreline Management Project</u> dated April 2016, was filed with EPA on April 20, 2016, and a notice of its publication appeared in the Federal Register on April 29, 2016. The Corps simultaneously issued a public notice requesting comment on the proposed activity, the alternatives and the FEIS. The FEIS was prepared in accordance with the Council on Environmental Quality (CEQ) regulations (40 CFR 1500-1508), the U.S. Army Corps of Engineers' regulations for implementing the National Environmental Policy Act of 1969 (33 CFR 230), as amended, and the U.S. Army Corps of Engineers' Regulatory Program regulations (33 CFR Part 325, Appendix B).

5. <u>Alternatives Considered</u>

a.) Alternative 1- No Action Alternative (Continued Current Management Practices), (Chapter 5 of the EIS). This alternative would involve management of the area in its current state with periodic sand nourishment on a three year interval under the existing federal Coastal Storm Damage Reduction Project (CSDRP) and maintenance of the currently existing sand bag revetments. The current CSDRP calls for the sand from Shallotte Inlet to be placed on Ocean Isle Beach in three year dredging cycles. Under the No-Action Alternative, short-term stabilization measures include the placement of emergency sand-bags every five years for protection of structures imminently threatened by erosion (in compliance with current state regulations) and the maintenance of the existing sand bag revetments.

b.) Alternative 2- Abandon/Retreat (No Action/No Permit Alternative), (Chapter 5 of the EIS). This alternative would involve continuation of federal beach disposal activities, as with Alternative 1, but the only difference would be when erosion impacts occur, no action would be taken to protect threatened homes and infrastructure. Under this alternative, there would be no maintenance of the existing sand bag revetments, applicant sponsored nourishment actions, or any other action requiring a Corps or State permit. This alternative would involve the relocation of threatened homes and infrastructure, including roads and utilities, to existing non-threatened areas on Ocean Isle Beach.

c.) Alternative 3- Beach Fill Only (Including Federal Project), (Chapter 3 and Chapter 5 of the EIS). Under this alternative, beach disposal would continue per the terms of the existing CSDRP, including additional non-federally sponsored beach fill along a 3,500-foot section on the east end of Ocean Isle Beach. Note that the beach fill placed under Alternative 3 would be in addition to the fill normally placed during periodic nourishment operations for the Federal storm damage reduction project. This proposal would involve private funding and would require the USACE to alter the periodic nourishment rate of the combined locally and federally sponsored CSDRP to every two years, instead of every three years as under the current authorization. In light of the calculated volumetric losses provided by the Applicant (see Alternatives 1 and 3, Chapter 5 of the FEIS), it is anticipated that the volume and frequency of nourishment and disposal events required to reduce the risk of further shoreline erosion is on the order of approximately 218,000 cubic yards/year. The additional nourishment attributed to the Alternative 3 fill, which is estimated to be 82,000 cubic yards/year, would be a non-federal responsibility. This calculation includes both the federal project and the locally sponsored beach fill project. The sand bag revetments would be maintained so as to continue the beneficial effect of reducing sand losses. The sand source associated with this alternative would be the same federal borrow area within Shallotte Inlet.

d.) Alternative 4- Shallotte Inlet Bar Channel Realignment with Beach Fill (Including Federal Project), (Chapter 5 of the EIS). Under this alternative, the proposal would be to repurpose the existing federal borrow area in Shallotte Inlet as a relocated inlet. To reach these means, the borrow area would be continuously dredged in a new “permanent” channel position aligning the same cut area for each nourishment operation, where the borrow area might eventually become the dominant flow path for waters exiting through the inlet. The initial beach fill for Alternative 4 would be the same as that described for Alternative 3 involving the placement of 387,000 cubic yards in addition to the volume of material normally placed on Ocean Isle Beach during periodic nourishment of the CSDRP. Periodic nourishment would also be the same as Alternative 3 (every 2 years) until the repeated removal of material from the west-side of the borrow area captures the majority of the flow through the inlet.

e.) Alternative 5- Terminal Groin with Beach Fill (Including Federal Project)/Applicant’s Preferred Alternative (Chapter 5). This alternative is described above and in Chapters 1 and 2 of the FEIS (Introduction and Description of the Applicant’s Proposed Project).

A detailed analysis of the anticipated environmental and socioeconomic consequences of each alternative is presented in Chapter 5 of the FEIS.

In accordance with 40 CFR Section 1505.2(b), I have selected Alternative 5 (Construction of a Terminal Groin with Associated Beach Fill) as the environmentally preferable alternative. The environmentally preferable alternative has been defined by the Council on Environmental Quality as "the alternative that causes the least damage to the biological and physical environment…." The evaluation of alternatives involved economic considerations, and the agency's statutory mission to consider Public Interest Factors and identify a Least Environmentally Damaging, Practicable Alternative (LEDPA). Reference Section 9 of this document for a detailed discussion on all alternatives and the selection of the LEDPA.

I have identified Alternative 5 as the LEDPA based on the project purpose, economic considerations and the environmental impacts associated with all alternatives. All other practicable alternatives would result in more direct, indirect, and/or cumulative impacts to the aquatic ecosystem. Additionally, in the long term all other alternatives would cost more than Alternative 5. The alternatives developed during the NEPA process are discussed in detail in Chapters 3 and 5 of the FEIS and Section 9 of this ROD.

6. <u>Impacts of the Proposed Action and Avoidance, Minimization and Mitigation Measures</u>

Impacts of the proposed action, including but not limited to impacts to waters of the United States, fish and wildlife resources, navigation, recreation, shoreline accretion and erosion are described below in Section 9 (404(b) (1) Analysis) and Section 10 (Public Interest Review). Also, Chapters 4 and 5 of the FEIS provide a full discussion of the environmental impacts associated with the proposed project. Comments received in response to the DEIS, FEIS and public notice for the Clean Water Act and Rivers and Harbors Act permit application are discussed in Section 8 of this document.

a. Avoidance, Minimization and Mitigation Measures

Avoidance, minimization and mitigation measures are described in Chapter 6 of the FEIS. The measures include the following:

- As required by NC Senate Bill 151, an inlet management plan, including mitigation measures is presented in Chapter 6 of the FEIS and incorporated in special conditions of this document. Should shoreline responses along Ocean Isle Beach or Holden Beach exceed the shoreline change thresholds presented in the EIS throughout the 2-year verification period, the terminal groin would be evaluated to determine first if modifications to the structure, then beach nourishment, or finally structure removal would mitigate the negative shoreline impacts.
- Beach fill will be compatible with the native beach receiving the fill and in compliance with the North Carolina Coastal Resources Commission State Sediment Criteria Rule (15A NCAC 07H .0312) to minimize impacts to the aquatic ecosystem and nesting or foraging species.

- A hydraulic cutter head dredge will be used during dredging operations and will operate only within construction windows and utilize positioning software to minimize impacts of sedimentation on aquatic life and aquatic habitats.
- The regularly maintained federal project area of Shallotte River will be used as a borrow source to ensure beach fill is compatible with the native beach receiving the fill.
- Previously dredged borrow areas will be used to minimize impacts to the aquatic ecosystem.
- All terms and conditions of the U.S. Fish and Wildlife Service's (USFWS) Biological Opinion will be incorporated as special conditions of any Corps authorization to minimize impacts to threatened and endangered species.
- The terminal groin structure will incorporate a 'leaky' design to allow for the transport of material and larval organisms down-drift of the structure.
- Alignment of the pipeline will be coordinated with, and approved by the USACE, NCDCM, USFWS, and the NCWRC. Monitoring for leak detection will also be conducted.
- Construction of the project has been designed to reduce the frequency of dredge and fill projects to maintain the shoreline from approximately 3 year intervals to approximately 5 year intervals. The project is expected to decrease the frequency and subsequently, over time, the amount of material dredged and disposed on the shoreline for each nourishment event.
- The location of the terminal groin and all dredging activities were designed to avoid impacts to cultural resources subject to the National Historic Preservation Act (NHPA).

7. <u>Other Required Coordination and Authorizations</u>

a. Cultural Resources

The applicant contracted Tidewater Atlantic Research, Inc. of Washington, North Carolina (TAR) to conduct a marine, terrestrial, and remote-sensing archeological survey of the proposed construction area. Field research for the project was conducted on 12 through 14 December 2014 when TAR conducted a magnetometer and side scan sonar survey of the offshore construction site and a magnetometer survey of the terrestrial construction area.

Analysis of the remote-sensing data generated during the Ocean Isle Beach survey identified a total of 22 magnetic anomalies in the offshore project environment and 4 anomalies in the terrestrial project environment. Sonar identified 16 targets in the marine environment. It was determined that all of the anomalies and all of the sonar images are associated with relic groin structures or small objects that represent debris associated with those groins or residential material deposited by storms. None of the anomalies and sonar images appears to represent more complex signatures associated with historic vessel remains. No additional investigation was recommended by TAR.

Consultation under Section 106, National Historic Preservation Act, has been concluded via coordination with the State Division of Cultural Resources. By letter dated May 16, 2016, the State Historic Preservation Officer responded to the FEIS and stated that they have no comments on the project. The permit will be conditioned to require that work cease in the event that any archaeological or historical resources are discovered. Such findings will require coordination with the Division of Cultural Resources prior to further construction.

b. Endangered Species

The applicant provided a biological assessment dated January 2015 and the Corps determined that the project may affect, but is not likely to adversely affect (MANLAA) the green sea turtle, loggerhead sea turtle (individuals), hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, piping plover, red knot, right whale, humpback whale, finback whale, sei whale, sperm whale, West Indian manatee, Atlantic sturgeon, shortnose sturgeon, seabeach amaranth and associated critical habitats of the piping plover. By letter dated January 21, 2015, the Corps requested concurrence from the USFWS and the National Marine Fisheries Service (NMFS) in accordance with the Endangered Species Act (ESA) of 1973 and 50 CFR 402. The Corps determined that the proposed project would not affect any other listed species protected by the ESA.

In the letter dated January 21, 2015, the Corps also requested the initiation of formal consultation with the USFWS concerning loggerhead sea turtle Critical Habitat. The Corps' initial determination was that the loss of Critical Habitat for nesting Loggerhead sea turtles as a result of the structure placement would adversely affect these species and their habitat. The Corps modified its effect determinations based on the information presented in the Biological Opinion (BO) dated August 6, 2015. The USFWS BO stated that the project may affect, but would not jeopardize the continued existence of the piping plover, red knot, seabeach amaranth, and green, Kemp's ridley, leatherback, and loggerhead nesting sea turtles. The BO concluded that loggerhead sea turtle critical habitat would not be adversely modified. The USFWS BO included concurrence with a MANLAA determination for the hawksbill sea turtle and West Indian manatee. The Corps agrees with these revised determinations. The USFWS' BO included terms and conditions to protect the species that the proposed project may affect and is likely to adversely affect. All terms and conditions of the BO will be incorporated as conditions of any Corps authorization including any monitoring or mitigating requirements.

In a letter dated March 3, 2016, the NMFS concurred with the Corps' initial determination that the project is not likely to adversely affect whales, sturgeon and swimming marine sea turtles. Because all potential project effects to listed species and critical habitat were found to be discountable, insignificant, or beneficial, NMFS concluded that the proposed action is not likely to adversely affect listed species under NMFS purview. All terms and conditions of the South Atlantic Regional Biological Opinion (SARBO) and the NMFS concurrence letter will be incorporated as special conditions in any Corps authorization for this project.

c. Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation Management Act established procedures for identifying Essential Fish Habitat (EFH) and required interagency coordination to further the conservation of federally managed fisheries. The Corps is required to consult with NMFS prior to authorizing any action that could adversely affect EFH.

The applicant completed an EFH assessment dated January 2015. By letter dated January 21, 2015, the Corps coordinated with the NMFS in accordance with the Magnuson-Stevens Fishery Conservation Management Act. The Corps determined that the proposed project may have minor adverse impacts on EFH or associated fisheries managed by the South Atlantic or Mid Atlantic Fishery Management Councils or the National Marine Fisheries Service. This determination was based on the project's description and the location of the project. The Corps anticipates that the effects of the project on EFH and federally managed fisheries would be minor and due largely to the temporary suspension of sediments in the water column at the construction site of the groin, and the excavation and nourishment sites.

In a letter dated May 31, 2016, NMFS stated that the expected activity will have cumulative effects from frequent dredging of the inlet based upon the frequency of inlet dredging utilized in navigation projects and other shoreline protection projects in the region. Secondarily, the NMFS is concerned about the impacts of beach nourishment on infaunal prey resources and foraging habitat provided by the beach shoreline complex. To address these concerns, the FEIS and EFH Assessment recommended a work moratorium from April 1 through November 15 to minimize environmental impacts and provide protections for seasonal migrations of fish and protected species (i.e., sturgeon, sea turtles) that will be incorporated as a condition of the permit. In the same letter, the NMFS indicated that they had no additional EFH conservation recommendations for the project outside of what the Corps proposed. The NMFS reserved the right to provide EFH conservation recommendations in the future, should new information or changes in the project design show that adverse impacts would occur to EFH or federally-managed fishery species.

d. Clean Air Act

Impacts to air quality associated with the project would be temporary and short term. The use of machinery for the construction of the groin, dredging and beach fill activities would result in temporary increases in pollution to the ambient air, but the activities are not anticipated to affect compliance with the National Ambient Air Quality Standard (NAAQS). It has been determined that the activities proposed under this permit will not exceed *de minimis* levels of direct or indirect emissions of a criteria pollutant or its precursors and are exempted by 40 CFR Part 93.153. Any later indirect emissions are generally not within the Corps' continuing program responsibility and generally cannot be practicably controlled by the Corps. For these reasons a conformity determination is not required for this permit action. Chapter 4 of the FEIS (Non-Relevant Resources) states that it is not expected that any activities associated with the proposed project alternatives would significantly contribute to air pollution within the permit area.

e. Clean Water Act Water Quality Certification

The Clean Water Act provides that the applicant must obtain from the NC Division of Water Resources (NCDWR) a Section 401 water quality certification that the proposed discharge will comply with applicable effluent limitations and water quality standards before a 404 Clean Water Act permit is issued. NCDWR issued an Individual 401 Water Quality Certification on August 11, 2016 with additional conditions. The additional conditions will be included in the DA authorization.

f. Coastal Zone Management Act Consistency Determination

The Coastal Zone Management Act requires that the applicant obtain a permit from the NCDCM for the proposed project. The NCDCM issued a conditioned permit on November 7, 2016 finding that the proposed project is consistent with the enforceable policies of North Carolina's coastal management program and the Coastal Zone Management Act.

g. Relevant Presidential Executive Orders

(1) EO 13175, Consultation with Indian Tribes, Alaska Natives, and Native Hawaiians. This action would have no substantial direct effect on one or more Indian tribes.

(2) EO 11988, Floodplain Management. Alternatives to work within the floodplain, minimization, and compensation of the effects are considered in Section 10 of this document.

(3) EO 12898, Environmental Justice. In accordance with Title III of the Civil Right Act of 1964 and Executive Order 12898, it has been determined that the project would not directly or through contractual or other arrangements, use criteria, methods, or practices that discriminate on the basis of race, color, or national origin nor would it have a disproportionate effect on minority or low-income communities. Environmental Justice is discussed further in Chapter 5.22 of the FEIS

(4) EO 13112, Invasive Species. There were no invasive species issues.

(5) EO 13212 and 13302, Energy Supply and Availability. The project is not one that will increase the production, transmission, or conservation of energy, or strengthen pipeline safety.

8. Consideration of Agency and Public Comments

The Corps received comments on the DEIS, FEIS and the Public Notice for the DA permit application for the proposed action. Comments received on the DEIS and FEIS focused mainly on issues and impacts to neighboring beach communities, the Delft 3D model, economic analyses, and threatened and endangered species.

Many comments were received in regards to the content of the DEIS, which resulted in editorial and factual changes to the document. The comments on the DEIS and Public Notice for the DA permit application were fully addressed and all comments and responses can be found in Appendix G of the FEIS and throughout the body of the FEIS.

All FEIS comments and responses to the comments are provided in Appendix A.

9. 404(b) (1) Analysis; 40 CFR Part 230

a. Factual Determinations (Chapters 3, 4 and 5 of the FEIS)

Pursuant to 40 CFR 230.11, the Corps must determine the potential short-term and long-term effects of a proposed discharge on the physical, chemical and biological components of the aquatic environment. These factual determinations shall be used in making a determination of compliance or non-compliance with the restrictions on discharge. The factual determinations are as follows:

(1) Physical Substrate Determinations. As described in Chapter 5 of the FEIS, **a**pproximately 1.37 acres of sandy substrate would be permanently impacted by the discharge of the rock material for the construction of the terminal groin. There would be some temporary effects to substrate resulting from the disposal of dredged material on 3,214 lf of shoreline on Ocean Isle Beach and dredging impacts to approximately 17 acres within Shallotte Inlet for borrow material on an approximately 5 year interval (previously authorized under the CSDRP on a 3 year interval). The material placed along the shoreline will be composed of sand that is compatible with the natural beach substrate. The rubblemound portion of the terminal groin would be constructed from a temporary trestle or pier installed parallel to the alignment of the terminal groin. The trestle would be removed upon completion of the rubblemound portion of the terminal groin. These impacts are considered temporary in nature. The project will require the use of heavy machinery on the beach during construction of the terminal groin; however compaction of the substrate is not anticipated due to the coarse sand material present along the shoreline. Individual and cumulative effects to all affected substrates would be minimal and temporary.

(2) Water Circulation, Fluctuation and Salinity Determinations. The proposed project is not expected to have a long term or appreciable effect on salinity, temperature, water chemistry, clarity, color, odor, taste, dissolved gas levels or increased/decreased nutrients or eutrophication within the water column. Water fluctuations and salinities are not expected to be affected by the proposed project. As discussed in Chapter 5 of the FEIS, water currents and circulation are expected to be affected upon the construction of the terminal groin. All affects to water circulation and fluctuation during dredging and disposal are expected to be temporary, negligible and minimal, however the impacts to water circulation resulting from the structure itself may be permanent. Several mitigating factors described below will assist in alleviating permanent negative impacts.

The terminal groin will allow for the accretion of material along the up-drift side of the structure and is expected to slow the transport of material down-drift of the structure. Water circulation along the up-drift side of the structure would be altered during the construction of the structure and immediately upon completion of the structure. However, long term alteration of currents and circulation would be minimized by the construction of the fillet behind the structure and the proposal for the groin to be a “leaky” structure. The terminal groin is expected to dissipate the energy of currents and will change the dimensions of the shoreline in the project area. As described in Appendix B of the FEIS, currents are not expected to be altered in a fashion that would increase erosion or otherwise adversely affect shorelines of neighboring communities to the east (Holden Beach). In the event that the terminal groin adversely affects the immediate shoreline, the applicant will be required to alter the height and/or the configuration of the terminal groin or remove the terminal groin in order to mitigate for the adverse effects (as proposed in the Inlet Management Plan and conditioned in any DA authorization). The applicant would be required, as a condition of any authorization, to monitor nearby shorelines to ensure that the project is not causing adverse effects, and would be required to place sand down drift of the structure to ameliorate negative impacts if they occur.

It is therefore my determination that individual and cumulative impacts to water circulation, flows, fluctuations and salinity will not be significant or unacceptable.

(3) Suspended Particulate/Turbidity Determinations. There would be a temporary increase in turbidity levels in the project area during construction activities. Turbidity would be short-term and localized with minimal adverse impacts to natural resources. The proposed beach fill and dredging operations would result in a temporary increase in turbidity near the construction areas. The grains of well-sorted sand with a low silt percentage would allow for a short suspension time and containment of sediment during and after construction. The settling time for the sand grains would be minimal and thus, light penetration would return to normal shortly after construction is completed. Also, best management practices as required in permit conditions would be employed to control the levels of particulates in the water column. Therefore, minimal impacts on the near shore and estuarine environments would be anticipated during construction. On August 11, 2016, the NCDWR issued a Water Quality Certification. A condition of the certification states that a turbidity standard of 25 Nephelometric Turbidity Units (NTU's) shall not be exceeded. The conditions of the water quality certification would be incorporated into the DA permit.

(4) Contaminant Determinations. Pursuant to 40 CFR 230.6(a) and (b), the Corps has determined that there is no reason to believe that contaminants are present in the project area. There are no known hazardous, toxic or radioactive wastes in the project area. The substrate composition in the project area is comprised of coarse sand and, as a result, is unlikely to contain any toxic or hazardous substances. Any DA permit issued for this project will be conditioned to require clean fill.

(5) Aquatic Ecosystem and Organism Determinations. Individual and cumulative impacts to aquatic ecosystems and organisms are expected to be minimal and/or mitigated based on the nature and duration of the proposed impacts and the location of the impacts in a dynamic environment that is subject to periodic natural disturbance. During the disposal of dredged material, immediate localized impacts originating from the covering of substrate and the abrupt increased sedimentation at the disposal area may temporarily affect fish and benthic organisms present in the immediate work areas, but would likely not have any permanent appreciable effect on aquatic resources. Fish and other mobile species are expected to leave the project areas during construction and are expected to return upon completion of the project. The project would however result in mortality of benthic and bivalve species during construction, but species from nearby unaffected areas are expected to recolonize the habitat in the affected areas upon completion of the project, given that the disposed material will be consistent with the material currently on the shoreline. Other wildlife, including birds and mammals, that are associated with the aquatic ecosystem are expected to return when the project area is recolonized with fish, bivalves and benthic organisms.

The Applicant provided a Biological Assessment and an Essential Fish Habitat (EFH) Assessment with the application for the project. The Corps reviewed those assessments and coordinated with the USFWS and NMFS concerning threatened and endangered species and EFH. USFWS concurred that the project is not likely to adversely affect the hawksbill sea turtle, or the West Indian manatee with applicant's use of the Guidelines for Avoiding Impacts to the West Indian Manatee. In a letter dated March 3, 2016, NMFS concurred that the project is not likely to adversely affect threatened and endangered whales, sturgeons and sea turtles. In a letter dated May 31, 2016, the NMFS Habitat Conservation Division concluded consultation on EFH without any EFH conservation recommendations for the project. In a BO dated August 6, 2015, the USFWS concluded consultation on the project's effects on threatened and endangered species by concluding that the project would not jeopardize the continued existence of species under their purview. Reference Sections 9 and 10 of this document for more information concerning the effects of the discharge to aquatic species and ecosystems.

(6) Proposed Disposal Site Determinations. The dredged material will be discharged in the Atlantic Ocean along the up-drift side of the proposed terminal groin structure for the construction of the fillet and subsequent nourishment events. The dredged material would consist of sandy material and would allow for a short suspension time and containment of sediment during and after construction. As a result, the mixing zone will be confined to the smallest practicable area within the disposal site.

The material will likely disperse in areas down-drift of the disposal site by way of natural sediment transport, but the dispersion is not expected to result in significant adverse environmental effects.

Nourishment activities along the shoreline are expected to be at approximately five year intervals. All dredged material will be consistent with the material currently on the beach. Additionally, the Section 401 Water Quality Certification contains conditions for maintaining appropriate sediment and erosion control measures. These conditions would be incorporated into any DA permit that is issued.

(7) Determination of Cumulative Effects. Cumulative impacts are the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material.

The geographic area for this cumulative effects assessment is limited to the shorelines along the NC coast. Shoreline projects along the NC coast are performed by the Wilmington District Corps of Engineers, municipalities and other entities are all subject to NC state laws and policies. Also, the natural areas that occur along the North Carolina coast, including the project area generally include similar aquatic habitat and species.

The first federal North Carolina beach nourishment projects were constructed at Carolina Beach and Wrightsville Beach in 1965. Both anthropogenic and natural events have in the past, and are projected to in the reasonably foreseeable future, impact the resources identified in the geographic range of this analysis. Examples of anthropogenic actions that may affect resources include actions such as: coastal structures interrupting supply of sediment to the coast; inlet creation, relocation or maintenance; beach nourishment projects; beach bulldozing and grading; dune enhancement; and population increase and associated domestic and industrial activity along the shoreline. Past and reasonably foreseeable future impacts identified as potentially contributing to cumulative effects on resources include nourishment events along most of the North Carolina shorelines, including Carolina Beach, Kure Beach, Masons Inlet, Wrightsville Beach, Figure 8 Island, Topsail Island, Bogue Banks, the Outer Banks, Oak Island, Ocean Isle and Holden Beach. The projection is that authorizations for nourishment activities along the NC shoreline will continue at the current rate. Additionally one terminal groin has been constructed on Bald Head Island and two other terminal groin projects are being proposed along the shoreline in the vicinity of the project (Holden Beach, Figure 8 Island).

As a result of database analyses conducted by the Wilmington District, the Corps summarizes the number of miles of the 320-mile beachfront of the North Carolina coast affected by authorized and/or proposed federal nourishment projects. Based on the frequency intervals of the individual projects and their cumulative impacts (evaluating existing and future projects over a 15-year period), the following conclusions were made:

- Average impact per year from existing nourishment = 2.9 mi or approximately 1% of NC shoreline.
- Maximum yearly impact (worst case) from existing beach nourishment activities = 9.8 mi or 3% of NC shoreline.
- Average impact per year from existing and proposed nourishment projects = 10.7 mi or 3.4% of NC shoreline.
- Maximum yearly impact (worst case) from existing and proposed nourishment projects = 47.1 mi or 14.7% of NC shoreline.

As described in Chapter 1 of the FEIS, the initial construction of the federal CSDRP in 2001 involved the placement of 1,866,000 cubic yards of material obtained from the Shallotte Inlet borrow area. The Shallotte Inlet borrow area was designated at the time of federal authorization as a source for future beach nourishment operations scheduled to occur every three years. Ocean Isle beach has been impacted by nourishment twice since the initial construction. Since the initial construction ~1,798,600 cubic yards of material has been placed within the limits of the CSDRP to date. There was also a non-federal component completed, resulting in the placement of 155,000 cubic yards along the shoreline, with 40,000 cubic yards of that in the CSDRP. An additional 300,000 to 400,000 cubic yards of material has been placed on the east end of Ocean Isle Beach since 2001 from maintenance of the AIWW.

The proposed terminal groin project is not typical of most other activities along the shoreline of North Carolina. The terminal groin structure at Ocean Isle Beach will be the second one constructed in the State of North Carolina since 1991. There are three existing terminal groins in North Carolina. A terminal groin structure was constructed at Fort Macon (Beaufort Inlet) in Carteret County in the 1960’s, another structure was constructed at the Pea Island Wildlife Refuge (Oregon Inlet) in Dare County in 1991, and more recently, a terminal groin was constructed in 2015 on Bald Head Island. The Beaufort Inlet and Oregon Inlet structures are discussed in more detail in Chapter 5 of the FEIS. There are also several other hard structures in multiple inlets of North Carolina, in the form of jetties, constructed to benefit navigation through inlets.

The key environmental issues associated with this project are impacts to fish and wildlife and to the shorelines of neighboring communities. Impacts to threatened and endangered fish, mammals, sea turtles, and birds are expected to be short-term and minimal with implementation of the terms and conditions of the USFWS' BO and use of the NMFS' SARBO for dredging operations. Aquatic ecosystem habitat lost as a result of this project would be immediately replaced with a comparably sized surf zone, consisting of beach compatible sand. Impacts to the aquatic ecosystem are discussed in Section 9.a, and Section 10 of this document. Overall, a decrease in the frequency of nourishment events along the affected shorelines is anticipated. Any adverse effects will be minimized by measures undertaken by the applicant. The magnitude of the proposed permanent effects are minimal along the shoreline. Compensatory mitigation for the loss of waters of the United States is not required based on the temporary nature of the impacts proposed in a dynamic coastal ecosystem, and the fact that no special aquatic sites would be impacted. However, mitigative measures as outlined in the Inlet Management Plan will be required as DA permit conditions.

The proposed terminal groin structure would stabilize the shoreline along the eastern shoreline of Ocean Isle Beach and is expected to result in less frequent nourishment events and less volumes of material to be discharged along the shoreline in each nourishment event. However, the terminal groin structure may increase erosion along the easternmost point of Ocean Isle Beach, down-drift of the structure. In order to address potential erosion issues along the easternmost portion of the beach, the applicant would be required to either alter the dimensions of the terminal groin to allow for more sand transport and mitigate negative shoreline impacts, or nourish the beach with sand from the terminal groin fillet, or remove the structure. The construction of the terminal groin is not expected to affect the shorelines of Holden Beach, because the sand transported to the east of the terminal groin structure would be intercepted by the deep navigation channel at the mouth of the Shallotte River Inlet. The navigation channel is regularly maintained and the sediments captured by the navigation channel would be dredged and disposed of along the shoreline or utilized for fillet maintenance in accordance with the Inlet Management Plan (described in Appendix G of this document). Should the monitoring surveys detect shoreline change rates exceeding the designated thresholds, the profile where the thresholds are exceeded will be "red flagged." Subsequent monitoring reports over the following two years will closely follow changes at these profiles to determine if corrective actions are needed. The Inlet Management Plan (Appendix G of this document) provides the following monitoring prescriptions and will be implemented as adaptive management conditions of any authorization:

-+(1) Beach profile surveys every 6 months covering 27,000 feet of shoreline on Ocean Isle Beach and 10,000 feet of shoreline east of Shallotte Inlet on Holden Beach.
(2) The beach profiles will be spaced at 500-foot intervals along both Ocean Isle Beach and Holden Beach.

(3) Annual hydrographic surveys of Shallotte Inlet extending from the confluence of the inlet with the AIWW seaward to the -30-foot NAVD depth contour in the ocean. The hydrographic surveys will cover the area from approximately station 400+00 on Holden Beach to station 0+00 on Ocean Isle Beach.
(4) The 9 radial profiles on the east end of Ocean Isle Beach and the 8 radial profiles on the west end of Holden Beach, as shown in Figure 6.2 of the FEIS, will be surveyed each spring and graphs prepared to show changes over time.
(5) The sand spit shoreline east of the terminal groin will be mapped from the aerial photos taken each spring and plots of the changes in the spit shoreline shown graphically.
(6) Similar shoreline mapping will also be performed on the Holden Beach side of Shallotte Inlet.

Any DA permit would require the applicant to monitor the shorelines of Ocean Isle Beach (west and east of the project area), Shallotte Inlet, and Holden Beach, and provide corrective measures by way of terminal groin alteration and/or nourishment along eroded shorelines determined to require adaptive management as a result of the project. In accordance with the Inlet Management Plan, the applicant would be required to implement terminal groin alterations prior to any nourishment event if the project causes an increase in erosion along neighboring shorelines. As described in the sections above, this terminal groin project is expected to reduce the frequency and magnitude of nourishment events along the eastern portion of Ocean Isle Beach.

The Corps has considered the cumulative impacts of the proposed project along with other similar projects along the North Carolina coast. All authorized nourishment projects have been individually conditioned to minimize environmental impacts. These conditions include the use of beach compatible sand, allowing work in time frames when oceanfront and aquatic organisms are least active and requiring conservation measures to further minimize impacts to the coastal environment. Therefore, the project would result in minimal cumulative impacts to aquatic habitat in the project area.

Cumulative effects associated with the project are further discussed in Chapter 5 of the FEIS.

(8) Determination of Secondary Effects. Secondary effects are effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material.

Minor and short term increases in turbidity are expected within the waters located along the shoreline. Turbidity is expected to be short term due to the nature of the coarse, sandy, beach compatible dredge material that will be placed along the shoreline.

Recreational use along the shoreline is expected to increase as a result of the project but the increases are not expected to adversely affect the aquatic ecosystem.

The terminal groin may trap debris and trash along the up-drift side of the structure, but effects on the aquatic ecosystem are expected to be minimal. The applicant and residents would have incentive to remove any unsightly debris located along the terminal groin structure to improve aesthetics.

The terminal groin would slow the movement of sediments and cause accretion in the vicinity of the structure, resulting in a larger shoreline. Any aquatic surf zone habitat lost as a result of the project is expected to be immediately replaced with a comparably sized surf zone. The accreted area would increase habitat for birds that are dependent upon the aquatic ecosystem along the shoreline.

The terminal groin structure may increase erosion along the downdrift side of the structure along Ocean Isle Beach. In order to address erosion issues requiring adaptive management along this section of the beach, the applicant would be required to alter the dimensions of the terminal groin to allow for more sand transport, nourish the beach with sand from the terminal groin fillet or other identified borrow area, and/or remove the structure entirely. In order to address any project induced erosion issues along Holden Beach that require adaptive management, the applicant would be required to nourish the beach with sand from the identified borrow area. During nourishment events, minor and short term increases in turbidity are expected within the waters located along the shoreline, but the turbidity is expected to be short term due to the nature of the coarse, sandy, beach compatible dredge material that will be placed along the shoreline.

An increase in residential, commercial or infrastructure development along the shoreline is not expected to occur as a result of this project given that any accreted land associated with a publicly funded project belongs to the state. However, the applicant may advocate for more lenient coastal management rules relating to setbacks and static lines. If the project does allow for increased development, such development would need to comply with state, federal, and local requirements so as to not directly impact the aquatic ecosystem.

b. Restrictions on Discharges

(1) Least Environmentally Damaging Practicable Alternative (LEDPA) and Practicability Evaluation. The 404(b) (1) Guidelines Restrictions on Discharge (40 CFR Part 230.10) specify that no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem. Part 230.10(a) (2) defines practicable as "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purpose." The determination of the LEDPA must be made without considering compensatory mitigation.

The purpose and need for this action is "To allow development of a shoreline protection project that would mitigate chronic erosion on the eastern portion on the Town's oceanfront shoreline so as to preserve the integrity of its infrastructure, provide protection to existing development, and ensure the continued use of the oceanfront beach along this area".

The following criteria were used to evaluate the proposed alternatives: Shoreline response, cost, impacts to the aquatic and terrestrial environment, and protection of property and infrastructure.

Alternative 1- No Action Alternative, (Chapter 5 of the EIS). As described in Section 5.a. of this ROD, this alternative would involve management of the area in its current state with periodic sand nourishment on a three year interval under the existing Coastal Storm Damage Reduction Project (CSDRP) and maintenance of the currently existing sand bag revetments. The current CSDRP calls for the sand from Shallotte Inlet to be placed on Ocean Isle Beach in three year dredging cycles. Under the No-Action Alternative, short-term stabilization measures are utilized, such as the placement of emergency sand-bags every five years for protection of structures imminently threatened by erosion (in compliance with current state regulations) and the maintenance of the existing sand bag revetments.	This alternative would involve the placement of sand as prescribed by the CSDRP. Applicant sponsored nourishment events would not occur under this alternative, however, the applicant would continue to participate in the CSDRP. This alternative includes emergency actions that would be taken by the applicant, such as beach bulldozing and the installation of sandbag revetments. Construction and maintenance costs associated with this alternative are expected to be approximately $101.5 million under a 3-year interval scenario over a 30-year planning horizon. According to the applicant's calculations, this alternative is expected to adversely affect one hundred fifty five (155) parcels along the shoreline as a result of shoreline erosion (refer to Table 3.1 and Figure 3.1 of the FEIS for the approximate location and costs associated with the anticipated MHW line). Of these parcels, forty-five (45) have dwellings on them. In addition to the loss of homes and parcels for tax bases, estimated damages to roads and utilities would total approximately $2.29 million, with the cost of installing temporary sandbag revetments equal to $5.40 million. The Applicant's estimated damages and erosion response costs over the next 30 years would total approximately $35.11 million. Approximately 32% of the total damages would occur within the first ten years of the 30-year planning period. However, to the extent that this alternative predicts future erosion risks to market participants, this additional value may be limited to current rather than long term improvements in market value. Even with partial or complete relocation of physical property, or the continued use for those properties not lost entirely, the decrease in value associated with these parcels can be expected to have a net adverse effect on the tax base of Ocean Isle Beach. The equivalent average annual cost is a means of comparing costs of various actions associated with each

	management alternative that would be implemented at different times during the analysis period. One way to interpret the equivalent average annual cost is to consider the amount of money one would have to invest each year at a given interest rate in order to pay for the estimated 30-year cost of the alternative. The equivalent average annual cost for Alternative 1 is $3,173,000. As described in Appendix B of the FEIS, calibrated Delft3D modeling of this alternative indicates that there will be considerable shoreline recession and deflation within nine years. In the event that structures are threatened by the shoreline erosion, the applicant may be authorized to bulldoze the beach and install sand bag revetments to protect threatened properties. Shoreline recession would directly impact dry beach, dunes and interdunal wetlands. Sand bag installation would directly and indirectly impact the dry beach and intertidal areas. In the event that sand bags are placed along the shoreline, intertidal aquatic ecosystems would likely be adversely affected and replaced by sub-tidal aquatic habitat. Beach bulldozing would increase, which would increase direct and cumulative impacts to the aquatic environment. Several species, including sea turtles and birds that are dependent on the aquatic ecosystem, may be adversely affected. This alternative is not practicable, as it would not meet the project purpose and need. This alternative would cost more than Alternative 5 and would also increase the frequency of direct impacts to the aquatic environment, resulting in higher cumulative environmental impacts than Alternative 5. Therefore, this alternative is not the least environmentally damaging alternative.

Alternative 2- Abandon/Retreat (No Action/No Permit Alternative), (Chapter 5 of the EIS). This alternative would involve continuation of federal beach disposal activities, as with Alternative 1, but the only difference would be when erosion impacts occur no action would be taken to protect threatened homes and infrastructure. This alternative does not include maintenance of the existing sand bag revetments, applicant sponsored nourishment actions, or any other action requiring additional Corps or State permits. This alternative would involve the relocation of threatened homes and infrastructure, including roads and utilities, to existing non-threatened areas on Ocean Isle Beach.	Under this alternative, shoreline recession is expected to migrate at historic rates, measured for each profile on the east end of the island (Appendix B of FEIS). As modeled, potential damages continued uniformly until the Year 2045. Future damages were based on the scarp migration rates provided in Table 4.1 of Appendix B of the FEIS. Given this shoreline retreat scenario, the same homes and infrastructure damaged or lost under alternative 1 would be damaged or lost under alternative 2. The total estimated cost of damages and erosion response measures under alternative 2 would be \$29.71 million which is \$5.40 million less than Alternative 1, due to eliminating the use of sandbags. Adding beach nourishment costs to the projected damages results in a total 30-year cost of \$96.15 million for Alternative 2. According to the applicant's calculations, this alternative is expected to adversely affect one hundred fifty five (155) parcels along the shoreline as a result of shoreline erosion (refer to Table 4.1 of Appendix B of the FEIS for the approximate location and costs associated with the anticipated MHW line). Of these parcels, forty-five (45) have dwellings on them. Shoreline recession will result in the loss and/or relocation of infrastructure, including roads, water lines, sewer lines, fire suppression, power lines and communication lines. Over the 30-years of anticipated erosion on the affected shoreline, approximately 1,800 linear feet of road and associated utilities will be lost. Table 4.2 in Appendix B of the FEIS provides the exact costs. The dollar value of damages to roads and associated utilities was based on replacement costs as a proxy since replacement would not be an option once erosion has overtaken the road. The equivalent average annual cost for Alternative 2 is \$3,084,000. The equivalent average annual cost is a convenient means of comparing costs of various actions associated with each

	management alternative that would be implemented at different times during the analysis period. One way to interpret the equivalent average annual cost is to consider the amount of money one would have to invest each year at a given interest rate in order to pay for the estimated 30-year cost of the alternative. This alternative would involve abandoning the lots, resulting in the loss of the property tax value to the Town and county. With this option, the individual homeowners would experience a larger expense in the relocation of the homes and the purchasing of new lots. Infrastructure, including roads and utility lines would have to be relocated at the expense of the applicant. Relocation of homes and utilities could result in direct impacts to wetlands and other waters of the United States located on the island. This alternative would only address erosion along the shoreline through the federal CSDRP but it would not extend further than previously authorized areas and therefore does not meet the Applicant's purpose and need. This alternative would result in a substantial loss of tax base and would result in an unreasonable expense and property value loss for the Town of Ocean Isle Beach and individual property owners.
Alternative 3- Beach Fill Only (Including Federal Project), (Chapter 5 of the EIS). Under this alternative, beach disposal would continue per the terms of the existing CSDRP, including beach fill along a 3,500-foot section on the east end of Ocean Isle Beach. In light of the calculated volumetric losses provided by the Applicant (see Alternatives 1 and 3, Chapter 5.0 of the FEIS), it is anticipated that the volume and frequency of nourishment and disposal events required to reduce the risk of further shoreline erosion is on the order of magnitude of 218,000 cubic yards/year. This	This alternative would involve applicant sponsorship of dredging and nourishment activities between nourishment events prescribed by the CSDRP. A private (non-federal) beach nourishment activity would occur every two years over the 3,500 foot section of Ocean Isle Beach shoreline. In light of calculated volumetric losses provided by the Applicant (see Chapter 3 of the FEIS), it is anticipated that the volume and frequency of Applicant-sponsored nourishment and disposal events required to reduce the risk of further shoreline erosion is on the order of magnitude

calculation includes both the federal project and the locally sponsored beach fill project. The sand bag revetments would be maintained so as to continue its beneficial effect by reducing sand losses. The sand source associated with this alternative would be the same federal borrow area within Shallotte Inlet.	of 218,000 cubic yards of sand per year (436,000 cubic yards between stations -5+00 and 120+00 every 2 years) for the life of the project (30 years). The total 30-year cost for Alternative 3, which includes continued nourishment of the coastal storm damage reduction project, is estimated to be $108.77 million. The equivalent average annual cost for Alternative 3 is $3,646,000. This alternative is practicable, but in the long term, this alternative would cost more than the applicant's preferred alternative, and involve the use of increased amounts of borrow material from Shallotte Inlet as compared to the applicant's preferred alternative. This alternative would maintain or increase the frequency of direct impacts to the aquatic environment, including maintaining the sand bag revetments along the shoreline. Also, when compared to the applicant's preferred alternative, more material would have to be placed along the shoreline for each nourishment event. This increase in frequency of direct impacts would result in more cumulative impacts to the aquatic environment than the applicant's preferred alternative, both along the shoreline and at the respective borrow sites. Appendix B of the FEIS further describes and quantifies the associated impacts of this alternative. Therefore, this alternative is not the least environmentally damaging alternative and its effects on the inlet and shoreline, in particular, outweigh any benefits associated with eliminating a hardened structure on the beach.
Alternative 4- Shallotte Inlet Bar Channel Realignment with Beach Fill (Including Federal Project), (Chapter 5 of the EIS). Under this alternative, the proposal would be to repurpose the existing federal borrow area in Shallotte Inlet as a relocated inlet. To reach these means, the borrow area would be continuously borrowed from in a new "permanent" channel position aligning the	This alternative would modify the dredging scheme to concentrate sediment removal for periodic nourishment along a channel that would be confined within the footprint of the borrow area that was used by the Corps of Engineers for initial construction of the Ocean Isle Beach federal storm damage reduction project (CSDRP).

same cut area for each nourishment operation, where the borrow area might eventually become the dominant flow path for waters exiting through the inlet.	Construction and maintenance costs over the 30-year planning period, including the periodic nourishment volumes along Ocean Isle Beach would cost a total of $53.15 million, while the costs associated with alternative 5 are $45,864,000. Even though volume losses off the east end of Ocean Isle Beach could be reduced through repetitive dredging of the borrow area in the same location, the cost of Alternative 4 over the 30-year evaluation period exceeded the 30-year cost of Alternative 5 by about 16%. Depending on funding, the federal government may continue to participate in periodic nourishment of the CSDRP by contributing 65% of the cost for providing beach fill within the authorized federal limits. Based on the projected decrease in periodic nourishment of the federal storm damage reduction project as presented in Table 3.3 of the FEIS and adjusting for fill that would be placed outside the limits of the federal project, the federal share over the 30-year planning period would be $30.89 million leaving a balance of $22.26 million of applicant costs. The equivalent average annual cost for Alternative 4 is $1,920,000. As described in Appendix B of the FEIS, results from analysis conducted in the Corps 1997 General Revaluation Report compiled for the 2001 CSDRP indicate potential benefits from channel realignment. Given this finding, the initial construction included channel realignment. However, following construction, the ebb tide delta material welded too close to the inlet to provide significant protection to development on the east end of Ocean Isle Beach (pg. 48 Appendix B of FEIS). Subsequent CSDRP operations did not maintain the preferred channel position and alignment, and instead utilized selective dredging required to obtain a sufficient amount of material. As described in Chapter 5 and Appendix B of the FEIS, Alternative 4 will result in increased

	environmental impacts and increased cost compared to Alternative 5. Environmental impacts would be higher for Alternative 4 due in part to the increased maintenance requirement at approximately every 4 years, as opposed to approximately every 5 years under Alternative 5. This alternative would result in an increased frequency of nourishment events and direct impacts to the aquatic environment from dredging and sand placement activities. Based on modeling results, periodic nourishment would be needed two years following the first re-dredging of the preferred channel alignment area. Following the second re-dredging, the next dredging/renourishment operation would be needed in three years. Subsequent nourishment/dredging operations would be needed every four years. This increase in frequency and direct impacts would result in more cumulative impacts to the aquatic environment than the applicant's preferred alternative, both along the shoreline and at the maintained inlet/borrow site. GIS analysis indicates indirect impacts to 1-2 acres of inlet dune habitat and 5-10 acres of inlet dry beach habitat. Marine, intertidal flat and intertidal shoal habitat would be subject to disturbance associated with 3 dredging events in the first 5 years under this alternative. Additionally, intertidal habitat would be subject to disturbance associated with changes in sediment transport. Therefore, this alternative is practicable, but is not the least environmentally damaging alternative.
Alternative 5- Terminal groin with beach nourishment/fillet construction (Chapter 3 of the EIS). This alternative is described above in Sections 1 and 2 (Introduction and Description of the Applicant's Proposed Project).	This alternative includes the construction of a terminal groin structure and the disposal of dredged material along the up-drift/western side of the structure for fillet construction. This alternative also includes applicant sponsored nourishment events to maintain the shoreline at approximately 5 year intervals. This alternative is expected to relieve the need for sandbag revetments and maintain the shoreline in a manner that reduces nourishment events and annualized sand losses following each nourishment event.

	Over a 30 year planning horizon, construction and maintenance costs associated with this alternative are expected to total approximately \$45,864,000 million. These values include an expected cost of \$1,567,000 million for construction of the terminal structure and associated fillet in the initial year. In the event of unanticipated negative impacts to adjacent shorelines, removal of the groin structure may be necessary. According to the applicant's engineer, the total cost associated with groin removal is estimated to be \$2 million. This alternative would involve the permanent discharge of fill material into approximately 1.37 acres of open waters of the United States. These permanent losses are associated with the construction of the terminal groin and fillet. Permanent losses to sub-tidal habitat are expected to be minimal given that there is an abundance of sub-tidal open water habitat along the coastline. The submerged portion of the groin is expected to provide habitat for fish and other marine organisms. GIS analysis indicates indirect impacts to 1-2 acres of inlet dune habitat and 5-10 acres of inlet dry beach habitat. Intertidal habitat impacts would be minimal given that the habitat would be immediately replaced upon completion of the project. Modeling suggests a total of 1-2 acres of intertidal habitat would be subject to disturbance associated with changes in sediment transport. As presented in Appendix B of the FEIS and described in Chapter 5, the extent and frequency of nourishment events are expected to decrease as a result of this project, resulting is less direct and cumulative impacts to the aquatic environment. Also, dry beach habitat for animals dependent on the aquatic ecosystem is expected to improve and increase as a result of this project. The option of

	altering or removing the structure, if negative impacts occur, and employing other adaptive management practices reduces the risk of permanent, unintended environmental consequences. As described in Chapter 3, Tables 3.11 and 3.12, of the FEIS, over the long-term this project would cost less than all other alternatives. It would also minimize use of the Shallotte Inlet borrow area. Therefore, this alternative is practicable, meets the project purpose, and involves less direct, indirect, and cumulative impacts to the aquatic ecosystem when compared with the other alternatives.

I have determined that all of the alternatives are logistically and technologically practicable. However, Alternative 1 and Alternative 2 do not meet the project purpose and need. Since Alternative 3 would maintain or increase the impacts from dredging and disposal events, it is not the least environmentally damaging alternative and would cost more than all other alternatives. Alternative 4 would cost more, and would result in greater impacts to aquatic resources than Alternative 5. Environmental impacts would be higher for Alternative 4 in part due to the three dredge and fill events expected within the first 5 years of the project, as well as the overall increased maintenance requirement (approximately every 4 years) opposed to approximately every 5 years under Alternative 5. The CSDRP maintenance cycle is currently approximately every 3 years. With the construction of the terminal groin alternative, the CSDRP maintenance cycle is anticipated to be reduced to approximately every 5 years thereby reducing impacts within the placement area to nesting sea turtles, shorebirds, and infaunal communities. In addition, with dredging occurring approximately every 5 years (rather than every 3 or 4 years with the other alternatives), the infaunal community within the footprint of the borrow area within Shallotte Inlet would have more time to recover, and there would be less frequent impacts to aquatic species including larval, juvenile, and adult finfish.

The terminal groin alternative, Alternative 5, is the least environmentally damaging practicable alternative. This alternative would meet the project purpose, decrease the frequency and extent of dredging and nourishment events within the aquatic ecosystem, and include adaptive management requirements, including monitoring and the modification or removal of the groin structure, if necessary.

b. Degradation of Waters of the United States

The 404(b) (1) guidelines state that the Corps may not issue a permit if it will result in significant degradation to the waters of the US. Under these guidelines, effects contributing to significant degradation, considered individually or collectively, include:

1. Significantly adverse effects of the discharge of pollutants on human health or welfare, including but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites;

2. Significantly adverse effects of the discharge of pollutants on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, including the transfer, concentration, and spread of pollutants or their byproducts outside of the disposal site through biological, physical, and chemical processes;
3. Significantly adverse effects of the discharge of pollutants on aquatic ecosystem diversity, productivity, and stability. Such effects may include, but are not limited to, loss of fish and wildlife habitat or loss of the capacity of a wetland to assimilate nutrients, purify water, or reduce wave energy; or
4. Significantly adverse effects of discharge of pollutants on recreational, aesthetic, and economic values.

The affected environment and the potential impacts, both direct and indirect, have been thoroughly examined in the FEIS. The likelihood and magnitude of these impacts are further discussed above in Section 9. The proposed project will not involve the discharge of fill material into special aquatic sites, as defined in 40 CFR part 230, Subpart E. The project as proposed will have minimal impacts to human health and welfare, aquatic life, aquatic ecosystems, recreation, aesthetics and economics. Aquatic life will either be killed during the construction of the project or will relocate to unaffected areas of the shoreline during construction. All aquatic life will return upon completion of the project. Beach compatible sand will be used in the disposal area and the intertidal and surf zone habitats will remain upon completion of the project. The project will have minimal and/or temporary impacts to recreation, aesthetics and economic values. Impacts to recreation, aesthetic and economic values are further discussed in Section 10 of this document.

After consideration of the above factual determinations, in light of the information contained in the FEIS and the overall record for this case, it is my determination that with the implementation of the attached Special Conditions, authorization of Alternative 5 will not cause or contribute to significant degradation of the waters of the US.

c. Avoidance and Minimization of Impact

Avoidance and minimization efforts are described in Chapter 6 of the FEIS and in Section 6 of this document. Pursuant to 40 CFR Part 230.10(d) I have considered whether all appropriate and practicable steps have been taken to minimize potential adverse effects to the aquatic ecosystem. Also, in accordance with the 1990 Memorandum of Agreement between EPA and the Corps regarding the determination of mitigation under the Clean Water Act 404(b)(1) guidelines, I have first considered avoidance through the determination of the least environmentally damaging practicable alternative and then considered further steps to minimize impacts to the aquatic environment. Any permit issued for this project will include special conditions to ensure that impacts to the aquatic resources are minimized.

I find that, with the minimization measures discussed above in Section 6 of this document, the applicant has taken all appropriate and practicable steps to minimize adverse impacts to the aquatic ecosystem.

10. <u>Public Interest Review</u>

All public interest factors have been reviewed as summarized here. Both cumulative and secondary impacts on the public interest were considered. The Public Interest Factors are discussed below.

+ Beneficial effect
0 Negligible effect
- Adverse effect
M Neutral as result of mitigative action

+	0	-	M	
	X			Conservation.
X				Economics.
	X			Aesthetics.
	X			General environmental concerns.
	X			Wetlands.
	X			Historic properties.
			X	Fish and wildlife values
X				Flood hazards.
X				Floodplain values.
X				Land use.
	X			Navigation
			X	Shoreline Erosion and Accretion
X				Recreation
	X			Water supply and conservation.
	X			Water quality
	X			Energy needs
	X			Safety
	X			Food and fiber production.
	X			Mineral needs
X				Considerations of property ownership.
X				Needs and welfare of the people.

a. Conservation.

The proposed project will not cause impacts to conservation or conservation areas. There are no designated conservation areas on Ocean Isle Beach. Avoidance and minimization efforts, as discussed above in this document and in Chapter 6 of the FEIS, have resulted in a project that minimizes impacts to the aquatic ecosystem, threatened and endangered species habitat and EFH to the maximum extent practicable.

b. Economics

The construction of the terminal groin would involve large initial costs associated with construction, but considerably lower costs associated with future beach nourishment. Construction of the terminal groin would provide long-term enhancements to beach width or beach quality and would convey additional economic benefits associated with tourism and recreation. Based upon the requirements of the state terminal groin legislation, mitigation action (e.g. fillet construction) would limit any potential for future loss of use or value of the protected shoreline. The use of a terminal groin in concert with a shoreline protection plan is expected to provide a host of benefits, including long-term infrastructure protection, enhanced beach width and volume, and enhanced recreation opportunities for the public. To the extent that the public views the terminal structure as reducing the risk of future erosion, this added stability should serve to enhance property values along these stretches of Ocean Isle Beach. Property values could be enhanced along the currently eroding parcels. Associated benefits and enhancements are likely to include increased rental revenues and higher tax revenues.

The project is expected to maintain or temporarily increase employment opportunities during the construction of the terminal groin and at the applicant's chosen rock mining facility. On-site jobs would be directly related to the construction of the project, while off-site jobs would be secondary effects due to the stimulation of commercial activities, particularly service-related businesses such as gas stations and restaurants in the project vicinity.

As a result of this project, the applicant's tax base would be maintained or increased due to a potential increase in tourism, recreation and property values. Also, long term costs of shoreline stabilization are expected to decrease with the presence of the terminal groin. Nourishment frequency and nourishment volumes are expected to decrease as a result of the project. A formal cost-benefit analysis was not completed or required for this project. More detailed information concerning economics is in Chapter 3 of the FEIS.

c. Aesthetics

Heavy machinery will be operating on the beach during construction of the project, which would result in temporary increases in noise. The presence of heavy machinery and other construction related material could also have a temporary effect on visual aesthetics. The project may increase fishing opportunities along the terminal groin structure which could attract more fishermen to the area and the structure may also trap floating debris and trash along the up-drift side of the structure, which may detract from the normal aesthetics of the area.

However, an increase in beach area and stabilization of the shoreline may improve aesthetic quality. This area has historically been impacted by beach construction/nourishment projects. No comments were received in response to the permit application, DEIS or the FEIS with regards to aesthetics. Impacts to aesthetics are expected to be negligible and minimal. More detailed information concerning aesthetics is provided in Chapter 5 of the FEIS.

d. General environmental concerns

Chapter 5.5 of the FEIS discusses general environmental consequences of the proposed action. The project could affect neighboring communities, recreation, and fish and wildlife values, including threatened and endangered species. Impacts to recreation, fish, wildlife and neighboring shorelines are further discussed throughout the FEIS and in Sections 10 and 11 of this document. Special conditions will be added to any authorization to require compliance with the terms and condition of the USFWS' BO and monitoring and mitigation for adverse effects to neighboring shorelines.

e. Wetlands

There are no wetlands or any other special aquatic sites located within the project area. No wetlands will be directly or indirectly impacted by the proposed construction of the terminal groin or any dredging associated with the construction of the fillet or nourishment of the shoreline.

f. Historic properties

As described in Section 7.a. of this ROD, the project will not affect any historic or cultural resources that are listed or eligible for listing in the National Register of Historic Places. The permit will include conditions that require consultation with the SHPO in the event that the project affects resources during construction. In a letter dated May 16, 2016, the State Historic Preservation Officer responded to the FEIS and stated that they have no comments on the project.

g. Fish and wildlife values

The open water and substrate areas occupied by the structure itself will be lost permanently. The other operations during dredging and disposal, are strictly localized impacts originating from removal of substrate and increased sedimentation at both the disposal and borrow areas that may temporarily affect fish and benthic organisms present in the immediate work areas. This will not have any permanent appreciable effect on aquatic ecosystems. Fish species are expected to leave the project areas during construction and are expected to return upon completion of the project. The project would result in mortality of benthic and bivalve species during construction, but species from nearby areas, outside of the project area, are expected to recolonize the habitat in the affected areas upon completion of the project as is typical with nourishment activities. These impacts and expected recovery timeframes are addressed in Chapter 5 of the FEIS.

The USFWS agreed that the project is not likely to adversely affect the West Indian manatee and hawksbill sea turtle, therefore those species and their habitats are not discussed in the BO. The USFWS' Guidelines for Avoiding Impacts to the West Indian manatee will be incorporated as special conditions of any authorization. The proposed project may affect and is likely to adversely affect the piping plover, red knot, seabeach amaranth, and the loggerhead, leatherback Kemp's Ridley, and green sea turtles. The applicant will be required to comply with all terms and conditions of the USFWS' BO dated August 6, 2015. All terms and conditions of the BO will be incorporated as special conditions of any Corps authorization. The USFWS' BO also includes measures to minimize impacts to migratory shorebirds in the project area.

NMFS concurred that the project is not likely to adversely affect threatened and endangered whales, sturgeons and sea turtles. A hopper dredge will not be used during construction, which would minimize potential impacts to threatened and endangered aquatic species, including sturgeons and sea turtles.

The project would occur in EFH, but impacts would be minimal and temporary. The proposed project will include dredging in Shallotte Inlet. By letter dated January 21, 2015, the Corps coordinated with the NMFS in accordance with the Magnuson-Stevens Fishery Conservation Management Act. The Corps determined that the proposed project would adversely affect EFH but the effects would be temporary and due largely to the temporary suspension of sediments in the water column at the excavation and nourishment site. In a letter dated May 31, 2016, NMFS stated that the expected activity is expected to adversely impact EFH and they offered no EFH Conservation Recommendations.

In order to minimize impacts to EFH and the aquatic ecosystem, the permit will be conditioned to require a work moratorium for April 1 through November 15 to minimize environmental impacts and provide protections for seasonal migrations of fish and protected species.

The project will result in the modification of habitat in the groin footprint and the dredging and disposal areas, including deepening of shallow bottom habitat in borrow areas and seaward displacement of intertidal and sub-tidal habitat adjacent to the fillet and beach fill areas. It is fully expected that nutrient cycling will continue, organic matter will continue to be provided and any changes in water quality will be temporary. Impacts associated with the project have been appropriately minimized, and are within acceptable limits. Individual and cumulative impacts to aquatic ecosystems and organisms are expected to be minimal.

This project would reduce erosion along the eastern shore of Ocean Isle Beach by allowing sand to accrete in the vicinity of the terminal groin structure. This accretion would increase and improve wildlife habitat, specifically for birds and sea turtles. The is the potential for some increased erosion along the downdrift side as a result of the project, but effects are anticipated to be minor in relation to current erosion rates, and the overall stabilization measures proposed in the project area.

h. Flood hazards and Floodplain values

As directed by Executive Order (EO) 11988, agencies shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare and to restore and preserve the natural and beneficial values served by floodplains. The proposed project involves work within the 100 year floodplain. However, the proposed project may reduce potential flood damage from storm surges and wave activity from the creation of a wider beach. Flood storage reduction is not expected to occur from the filling of waters of the United States. Flood hazards to properties on the shoreline are expected to decrease with the construction of the project and the increase in beach width. The shoreline would expand seaward and the profile of the beach is expected to increase in elevation as a result of the project, which would allow for more protection of the shorelines and properties during storm events. Dune systems would not be negatively affected as a result of the project and may be beneficially affected as the shoreline stabilizes waterward of the dune systems.

If any floodplain permits are required by any local entities, the applicant will be required obtain the authorizations prior to commencing work.

i. Land use

Project construction is expected to take approximately 6 months and public use of the shoreline in the project area will be temporarily restricted during construction of the project. Land use effects of the project would be consistent with other beach nourishment projects of the past and the project will not adversely affect the land use along the shoreline of Ocean Isle Beach. The terminal groin is expected to produce a larger and wider beach in the project area and is expected to maintain the existing land uses along the shoreline. Chapter 5.15 of the FEIS includes more information concerning land use.

j. Navigation

The project will occur in navigable waters of the United States. The applicant's proposed project involves the construction of a terminal structure which could potentially serve to modify wave energy along the non-federal shallow draft navigation channel's centerline. In that regard, the project is predicted to result in a small net reduction in local wave height to the east of the structure. This could be considered as beneficial to navigation interests. This project will not restrict navigation within navigable waters in any way.

The Corps coordinated internally with the Wilmington District's Section 408 (33 USC 408) Coordinator regarding the potential effects from construction of the terminal groin and the subsequent borrow effects on the federal Coastal Storm Damage Reduction project (Shallotte Inlet). In a letter dated May 19, 2016 the SAW District Engineer granted the request to alter the CSDR project, based on the determination that the action will not be injurious to the public interest or impair the federal project. Therefore, with respect to 33 USC 408, and following internal coordination, it was determined that the project would have no adverse impacts on the federal CSDR project.

The applicant will be required to contact the NOAA/National Ocean Service (NOS) prior to construction and they will be required to submit a report to the NOS, documenting the start date, end date and location of the completed structure. The structure will be charted for navigation purposes. The applicant will also be required to coordinate with the USCG to assure that all appropriate navigational aids will be installed along the structure

k. Shore erosion and accretion

As stated by the applicant, this project would serve to mitigate chronic erosion experienced along the eastern portion on the Ocean Isle Beach shoreline by allowing the sand to accrete in the vicinity of the terminal groin structure. This accretion would help protect properties along the shoreline and ensure the continued use of the oceanfront.

This project has potential to cause the eastern shoreline of Ocean Isle Beach to erode at a faster rate. However, long term alteration of currents and circulation would be minimized by structure design and the construction of the fillet behind the structure. Additionally, in order to address potential erosion issues requiring adaptive management along this eastern portion, the applicant would be required to alter the dimensions of the terminal groin or remove it completely to allow for more sand transport, and/or nourish the beach with sand from the terminal groin fillet.

The construction of the terminal groin is not expected to affect the shorelines of Holden Beach or Sunset Beach, which are located east and west of the terminal groin (respectively), because the sand transported to the east of the terminal groin structure (toward Holden Beach) would be intercepted by Shallotte Inlet. The inlet channel is regularly maintained and the sediments captured by the channel would be dredged and disposed of along the neighboring beaches in accordance with the Shallow Draft Inlet management plan. Modeling results show that areas to the west of baseline station 30+00 (including Sunset Beach and Tubbs Inlet) would not be impacted by the terminal groin as the primary direction for littoral transport is from west to east (Appendix B of FEIS). However, the applicant will be required to monitor the shoreline of Ocean Isle Beach and Holden Beach to ensure that the terminal groin structure and dredging within Shallotte Inlet would not result in accelerated erosion or depletion of sand resources on Holden Beach. A baseline shoreline threshold will be established for the eastern end of Ocean Isle Beach and the extreme western end of Holden Beach (federal project threshold). If any aspect of the project causes shoreline erosion to exceed those thresholds, the applicant will be required to address the erosion by either placing or pushing sand along the affected shoreline, placing sandbags and/or altering or removing the terminal groin (See Chapter 6 of the FEIS).

The permit will include conditions (below) that require the applicant to monitor the shorelines of Ocean Isle Beach and the extreme western end of Holden Beach and provide mitigation, by way of shoreline stabilization or terminal groin removal or modification, to address any project related erosion along the shorelines:

(1) Beach profile surveys every 6 months covering 27,000 feet of shoreline on Ocean Isle Beach and 10,000 feet of shoreline east of Shallotte Inlet on Holden Beach.
(2) The beach profiles will be spaced at 500-foot intervals along both Ocean Isle Beach and Holden Beach.
(3) Annual hydrographic surveys of Shallotte Inlet extending from the confluence of the inlet with the AIWW seaward to the -30-foot NAVD depth contour in the ocean. The hydrographic surveys will cover the area from approximately station 400+00 on Holden Beach to station 0+00 on Ocean Isle Beach.
(4) The 9 radial profiles on the east end of Ocean Isle Beach and the 8 radial profiles on the west end of Holden Beach, as shown in Figure 6.2 of the FEIS, will be surveyed each spring and graphs prepared to show changes over time.
(5) The sand spit shoreline east of the terminal groin will be mapped from the aerial photos taken each spring and plots of the changes in the spit shoreline shown graphically.
(6) Similar shoreline mapping will also be performed on the Holden Beach side of Shallotte Inlet.

Any permit associated with this project would require the applicant to monitor the shorelines of Ocean Isle Beach (west and east of the project area), Shallotte Inlet, and Holden Beach profiles, and provide corrective measures by way of terminal groin alteration and/or nourishment along the eroded shorelines. As described in the sections above, this terminal groin project is expected to reduce the frequency and magnitude of nourishment events along the eastern portion of Ocean Isle Beach.

l. Recreation

The applicant's proposed shoreline would extend beyond the ends of the existing sandbag revetments, which would result in a continuous shoreline, composed mostly of sandy beach. Therefore, the project would likely improve fishing, surfing, swimming, beach walking, and paddle sport opportunities along the shoreline.

Portions of the Ocean Isle beachfront will become an active construction area temporarily unavailable for daily recreational uses. However, the project will likely be constructed during the winter season which will reduce the impacts to recreation due to decreased visitation. Individuals seeking recreational opportunities along the beachfront will have to use beach areas located outside of the project area during construction. Daily recreational activities are expected to continue upon completion of dredge disposal and construction.

The construction of the terminal groin will create a larger and wider beach in the project area, which may increase recreational use along the shoreline.

The construction of the terminal groin may improve fish habitat in the areas of the exposed rock. It is likely that more fish would congregate around the exposed rock of the terminal groin, which may increase recreational fishing opportunities. Chapter 5 of the FEIS addresses impacts to recreational resources.

m. Water supply and conservation

The project will require the use of estuarine/salt water during construction of the project and all water will return to the ocean upon discharge of the dredged material. The project is not located in a water supply watershed or near water supply intakes or any other drinking water supply facilities. The project will not affect the availability of fresh water supplies.

n. Water quality

Clean fill material will be used to construct the terminal groin. Beach compatible sand will be used for the construction of the fillet and any subsequent nourishment activities, and the turbidity caused by the placement of sand would be temporary. On August 11, 2016, the NC Division of Water Quality issued a conditioned Water Quality Certification pursuant to Section 401 of the Clean Water Act, finding that proposed project will not result in a violation of applicable Water Quality Standards given that certain turbidity standards are met. The permit will be conditioned to require the use of clean fill and beach compatible sand.

o. Energy needs

Fossil fuels will be used by the machinery during construction of the project and during subsequent nourishment events. Demand for fossil fuels is expected to temporarily increase in the local area as a result of the project. Upon completion of the project, there should be no appreciable change in energy demands in the form of electricity and fossil fuels.

p. Safety

The terminal groin will be constructed in navigable waters of the United States and in territorial seas. The applicant will be required to contact the NOAA/National Ocean Service (NOS) prior to construction and submit a report to the NOS, documenting the start date, end date and location of the completed structure. The structure will be charted for navigation purposes.

During construction of the project, all work areas would be clearly marked and cordoned off to protect public health and safety.

The applicant will coordinate with the USCG to ensure that all appropriate navigational aids will be installed along the structure.

q. Food and fiber production

The authorization of the proposed project will not directly result in any production of food or fiber and will not have a negative effect on the production of food or fiber. The proposed project will not affect any land that is suitable for agricultural and silvicultural production.

r. Mineral needs

Sand and rock will be needed for the construction of the project. The project will require the use of quarried stone for the construction of the terminal groin. A temporary increase in mining at an existing mine site is expected as a result of this project. Sand material will be dredged from Shallotte Inlet for the construction of the fillet and for nourishment events.

s. Considerations of property ownership

The work will not permanently affect full and free access to surrounding properties, the shoreline or navigable waters in the area. Use and access of the shoreline in the project area will be temporarily restricted during the construction of the project.

The work will not result in any degradation of properties located along the shoreline and will provide beneficial effects to private and publicly owned properties. If the terminal groin structure results in the erosion of the shorelines of neighboring communities to the extent that adaptive management is required, the applicant will either alter or remove the groin or replace the sand lost along the shoreline. The applicant will be required to monitor the shorelines of neighboring communities to document any erosion of nearby shorelines.

The project will occur in the vicinity of an authorized federal project. The proposed project is expected to be compatible with the purposes of the federal project. Reference Section 10.j. above for more information concerning effects to the federal CSDR project. The permit will include conditions that require the removal of the structure if it interferes with the federal project.

It is my determination that the authorization of the proposed project would allow reasonable use of the property while sufficiently protecting the rights of surrounding property owners and the general public through the reduction of shoreline erosion on Ocean Isle Beach. In the event that the project increases erosion along the eastern shoreline, the applicant will take measures to address the erosion by altering or removing the terminal groin or nourishing the beach along the shoreline.

t. Needs and Welfare of the People

The proposed project may improve storm protection and potentially reduce future potential storm damage to the beach and adjacent coastal properties and infrastructure.

11. Territorial sea, activities affecting coastal zones, activities in Marine Sanctuaries.

This project would be located within territorial seas. The project would result in a larger beach area and the mean low water line would shift no more than 750 feet seaward, tapering back to recent shoreline configurations within a fairly short distance. The baseline from which territorial sea is measured is not anticipated to be altered given that the project would stabilize the shoreline in a fashion that is comparable to the average mean high water level measured over the past few decades.

The project is located in a coastal zone and is consistent with the objectives of the Coastal Zone Management Act. NCDCM issued a conditioned Coastal Area Management Act (CAMA) permit for the proposed project on November 7, 2016.

This project will have no effect on Marine Sanctuaries.

12. Other federal, state or local requirements

The issuance of any authorization for this activity does not remove the responsibility of the applicant to obtain any other required federal, state or local authorizations.

13. Findings and Conclusions

I have reviewed the proposed project pursuant to the 404(b) (1) guidelines (40 CFR Part 230). On the basis of my analysis, discussed in greater detail in Section 9, above, I find that Alternative 5 is the least environmentally damaging practicable alternative. Alternative 5 avoids and/or minimizes impacts to waters of the United States to the maximum extent practicable with the inclusion of the attached DA permit special conditions. I have also found that the applicant's proposed work would not cause or contribute to significant degradation of the waters of the United States.

I have reviewed and evaluated the impacts of this application, considering all relevant public interest factors as discussed in Section 10 of this document, the impacts of this application as described in the FEIS, and the comments of federal and non-federal agencies, environmental groups and other members of the public.

I find that the work can be permitted in accordance with regulations published in 33 CFR Parts 320-332. My decision to issue this permit is based on my evaluation of the probable impacts, including cumulative impacts, as described in the FEIS, and anticipated effects on the public interest. Evaluation of the probable impacts that the proposal could have on the public interest included a careful weighing of all relevant factors. The benefits that reasonably could be expected to accrue from the proposal and the economic benefit of the proposal were balanced against reasonably foreseeable potential detriments, including the loss of waters, and impacts to fish, wildlife and aquatic and beach habitat. I have considered the overall impacts to waters, both individually and cumulatively, and find that the benefits outweigh the detrimental impacts.

I have also evaluated the extent and permanence of the beneficial and/or detrimental effects of the proposed work on the public and private uses to which the area is suited. The proposed project would protect properties by stabilizing the shoreline and reducing flooding risks, improve recreational value along the shoreline and reduce the costs of shoreline stabilization in the long term. Concerns have been raised about potential cumulative impacts to aquatic and terrestrial habitat, threatened and endangered species and neighboring communities. Potential detriments of the project are expected to be short term and mitigated if necessary through adaptive management. Permit conditions requiring monitoring and, if necessary, remedial action, would address these concerns. The benefits of the proposed project on beach habitat, recreational values, flood damage reduction, land use, and the economy of the project area would be permanent as authorized by the DA permit.

I find that the proposed project (i.e., Alternative 5) is not contrary to the public interest, and that there are no practicable alternatives that meet the applicant’s purpose and need that have less environmental impacts. My decision reflects the national concern for both protection and utilization of important resources, as well as the relative extent of public need for the proposed work. The State of North Carolina has considered the potential water quality impacts of the proposed project and has issued a conditioned Clean Water Act Section 401 Water Quality Certification for the Project. The State has also issued a permit ensuring consistency with the Coastal Zone Management Act.

The project’s effects on species protected by the ESA have been evaluated and concluded through consultation pursuant to Section 7, of the ESA. The NMFS concluded that the project may affect, but would not likely affect species under their purview nor adversely modify or destroy critical habitat. The USFWS concluded formal consultation for species under their purview with a BO containing certain terms and conditions that will be made part of the DA permit issued for this project.

Consultation under Section 106, National Historic Preservation Act, has been concluded via coordination with the State Division of Cultural Resources. By letter dated May 16, 2016, the State Historic Preservation Officer responded to the FEIS and stated that they have no comments on the project. Furthermore, the permit will be conditioned to require work cease in the event that any archaeological or historical resources are discovered. Such findings will require coordination with the Division of Cultural Resources prior to further construction.

I have considered the comments of federal agencies, as well as state and local agencies, environmental groups, and other interested members of the public. I find that the project complies with the 404(b) (1) guidelines, 33 CFR Parts 320-332, 33 U.S.C 1344 and 33 U.S.C. 403 and is not contrary to the public interest. Therefore, I am issuing the DA permit for Alternative 5 to include the attached Special Conditions.

Kevin P. Landers, Sr.
Colonel, U.S. Army
District Commander

ACTION ID SAW-2011-01241
PERMIT SPECIAL CONDITIONS

This Permit authorizes impacts associated with Alternative 5, which includes the construction of the terminal groin, dredging and the construction of a fillet and subsequent nourishment events.

1. In accordance with 33 U.S.C. 1341(d), all conditions of the North Carolina Division of Coastal Management CAMA Permit 107-16 dated November 7, 2016, and the North Carolina Division of Water Resources 401 Water Quality Certification, dated August 11, 2016, are incorporated by reference as part of the Department of the Army permit. Therefore, they are not listed below as special conditions. A moratorium on shoreline activities from April 1 to November 15 of any year will be instituted as directed by and through consultation with USFWS.

2. All work authorized by this permit must be performed in strict compliance with the attached plans, which are a part of this permit. Any modification to these plans must be approved by the U.S. Army Corps of Engineers (USACE) prior to implementation.

3. Dredging activities authorized by this permit shall not in any way interfere with those operations of the USACE Civil Works dredging and navigation projects. Specifically, there shall not be any interference with the USACE maintenance of Shallotte Inlet associated with the Coastal Storm Damage Reduction Project.

4. The permittee shall require its contractors and/or agents to comply with the terms and conditions of this permit in the construction and maintenance of this project, and shall provide each of its contractors and/or agents associated with the construction or maintenance of this project with a copy of this permit. A copy of this permit, including all conditions, shall be available at the project site during construction and maintenance of this project.

5. Except as authorized by this permit or any USACE approved modification to this permit, no excavation, dredging or fill activities shall take place at any time in the construction or maintenance of this project, within waters or wetlands. This permit does not authorize temporary placement or double handling of dredged material excavated or material within waters of the United States outside of the permitted fill sites.

6. Except as authorized by this permit or any USACE approved modification to this permit, no excavation, dredging or fill shall take place at any time in the construction or maintenance of this project, in such a manner as to impair normal flows and circulation patterns within waters or wetlands or to reduce the reach of waters or wetlands.

7. All mechanized equipment will be regularly inspected and maintained to prevent contamination of waters and wetlands from fuels, lubricants, hydraulic fluids, or other toxic materials. In the event of a spill of petroleum products or any other hazardous waste, the

permittee shall immediately report it to the N.C. Division of Water Resources at (919) 733-5083, Ext. 526 or (800) 662-7956 and provisions of the North Carolina Oil Pollution and Hazardous Substances Control Act will be followed.

8. The permittee shall advise the Wilmington District, Regulatory Division in writing prior to beginning the work authorized by this permit. The contractors name, phone number, and address, including any inspector's contact name and phone number must be provided to the Wilmington District prior to initiating any work.

9. The permittee shall coordinate with the USACE Wilmington District, Regulatory Division, prior to any terminal groin construction or maintenance activities, any nourishment events in the project area, and prior to any modification to the terminal groin structure. Specifically, the permittee shall provide the plans for any such event to the Regulatory Division at least 30 days in advance of proposed contract solicitation for each maintenance or nourishment event. Such plans shall be supported by a narrative, and shall be in sufficient detail to adequately describe the footprint, timing, and execution of the work, and adequately identify all borrow, nourishment, and staging areas. Work on any maintenance or nourishment event shall not begin until the permittee receives the written concurrence of the Wilmington District, Regulatory Division.

10. The permittee shall employ all sedimentation and erosion control measures necessary to prevent an increase in sedimentation or turbidity within waters and wetlands outside the permit area. Additionally, the project must remain in full compliance with all aspects of the Sedimentation Pollution Control Act of 1973 (North Carolina General Statutes Chapter 113A Article 4).

11. Violations of these permit conditions or violations of Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act must be reported in writing to the Wilmington Regulatory Field Office, Attn: Mr. Tyler Crumbley, Wilmington District U.S. Army Corps of Engineers, 69 Darlington Ave., Wilmington, NC 28403, tyler.crumbley@usace.army.mil, (910) 251-4170 within 24 hours of the permittee's discovery of the violation.

12. The permittee, upon receipt of a notice of revocation of this permit or upon its expiration before completion of the work will, without expense to the United States and in such time and manner as the Secretary of the Army or his authorized representative may direct, restore the water or wetland to its pre-project condition.

13. All material used for the beach nourishment must be beach compatible, clean, free of debris and clay, and free of any pollutants except in trace quantities. The permittee shall ensure that an inspector is present during all beach disposal activities and immediately report to the USACE in the event any incompatible material is placed on the beach. During dredging operations, material placed on the beach shall be inspected daily to ensure compatibility. During dredging operations, a sediment analysis of the material placed on the beach, including shell content (calcium carbonate) percentage shall be submitted to the Wilmington District, Regulatory Division, Wilmington Regulatory Field Office, Attn: Mr. Tyler

Crumbley, on a WEEKLY basis until completion of the project. If during the sampling process non-beach compatible material is or has been placed on the beach all work shall stop immediately and the USACE notified by the permittee and/or its contractors to determine the appropriate plan of action.

14. A representative of the USACE, Regulatory Division will periodically and randomly inspect the work for compliance with these conditions. Deviations from the permitted activities and permit conditions may result in cessation of work until the problem is resolved to the satisfaction of the USACE. No claim, legal action in equity or for damages, adjustment, or other entitlement shall be asserted against the United States on account of any such required cessation or related action, by the permittee, its agents, contractors, or other representatives.

15. The permittee shall provide written notification of project completion immediately upon completion of the work authorized by this permit.

16. This Department of the Army permit does not obviate the need to obtain other Federal, State or local authorizations required by law.

17. The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the USACE, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal, relocation, or alteration.

18. The authorized project must not interfere with the public's right to free navigation on all navigable waters of the United States. No attempt will be made by the permittee to prevent the full and free use by the public of all navigable waters at or adjacent to the authorized work for any reason other than safety.

19. The permittee will comply with all U.S. Coast Guard regulations for dredging operations. The permittee will contact Mr. Scott McAloon, U.S. Coast Guard, District 5 Waterways at (252) 247-4525 at least 30 days prior to construction. Contact with the U.S. Coast Guard will initiate the Local Notice for Mariners procedures to ensure all safety precautions for aids to navigation are implemented. The permittee will notify our office when this coordination with the U.S. Coast Guard has been commenced and updates will be provided to our office.

20. The permittee must install and maintain, at his expense, any signal lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, on authorized facilities. For further information, the permittee should contact the U.S. Coast Guard Marine Safety Office at (910) 772-2200.

21. In issuing this permit, the Federal Government does not assume any liability for:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.
b. Damages to the permitted project or uses thereof as a result of current or future Federal activities initiated on behalf of the general public.
c. Damages to other permitted or unpermitted activities or structures caused by the authorized activity.
d. Design and construction deficiencies associated with the permitted work.
e. Damage claims associated with any future modification, suspension, or revocation of this permit.

22. The permittee shall notify NOAA/NATIONAL OCEAN SERVICE Chief Source Data Unit N CS261, 1315 E West HWY- RM 7316, Silver Spring, MD 20910-3282 at least two weeks prior to beginning work and upon completion of work. Upon completion of work, the permittee shall complete the attached form, titled Permit/Public Notice Completion Report. The form shall be submitted to the USACE, Regulatory Division and to NOAA/National Ocean Service.

THREATENED AND ENDANGERED SPECIES (NMFS PRD)

Terms and Conditions (as described in the NMFS Concurrence Letter dated March 3, 2016)

23. The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.

24. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

25. Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service’s Protected Resources Division, St. Petersburg, Florida.

26. All vessels associated with the construction project shall operate at “no wake/idle” speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

27. If a sea turtle or smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle or smalltooth sawfish. Operation

of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

28. Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824- 5312) and the local authorized sea turtle stranding/rescue organization.

THREATENED AND ENDANGERED SPECIES (USFWS)

Terms and Conditions for All Species

29. All derelict coastal armoring geotextile material and other debris must be removed from the beach prior to any sand placement or construction to the maximum extent possible.

30. Conservation Measures included in the permit application/project plans must be implemented for the proposed project. If a Reasonable and Prudent Measure (RPM) and Term and Condition address the same requirement, the requirements of the RPM and Term and Condition take precedent over the Conservation Measure. This includes the timing of the proposed project to avoid the sea turtle nesting season, to reduce the possibility of sea turtle nest burial, crushing of eggs, or nest excavation.

31. Predator-proof trash receptacles must be installed and maintained during construction at all beach access points used for the project construction and sand maintenance events, to minimize the potential for attracting predators of sea turtles, piping plovers, and red knots. All contractors conducting the work must provide predator-proof trash receptacles for the construction workers. All contractors and their employees must be briefed on the importance of not littering and keeping the Action Area free of trash and debris. See **Appendix A of the BO** for examples of suitable receptacles.

32. A meeting between representatives of the contractor, the Service, NCWRC, the permitted sea turtle surveyor, bird and other species surveyors, as appropriate, must be held prior to the commencement of construction of the terminal groin. At least 10 business days advance notice must be provided prior to conducting this meeting. The meeting will provide an opportunity for explanation and/or clarification of the required measures in the BO, as well as follow-up meetings during construction.

33. In the event the structure begins to disintegrate, all debris and structural material must be removed from the nesting beach area and deposited off-site immediately upon coordination with the Service. If removal of the structure is required during the period from April 1 to November 15, no work will be initiated without prior coordination with the USACE and the Service.

34. The permittee must submit all reports produced pursuant to the Inlet Management Plan (referenced in the revisions to North Carolina General Statute 113A-115.1(e)(5)) to the USACE and the Service's Raleigh Field Office, within 30 days of completion of each report.

35. If the USACE determines that adaptive management of the terminal groin is required based on monitoring results and the requirements of the Inlet Management Plan, the permittee shall complete, at its own expense, the adaptive management actions required by the USACE. Upon receipt of USACE notification that the groin structure is causing a significant adverse impact to the beach and dune system adjacent to the project area, the permittee shall submit a detailed adaptive management plan to the USACE within 30 days describing the proposed adaptive management actions, which may include the modification or removal of the terminal groin and/or supplemental beach nourishment in accordance with the Inlet Management Plan. The USACE reserves the right to fully evaluate, amend, and approve or reject the adaptive management plan. Upon receipt of USACE approval, the permittee shall complete the work as approved in the adaptive management plan within a reasonable timeframe, as determined by the USACE.

36. During construction of the terminal groin, and for the life of the permit, all sand placement activities to maintain the sand fillet must be conducted within the winter work window (November 16 to March 31), unless necessitated by an emergency condition and approved by the USACE after consultation with the Service.

37. The pipeline placement must be coordinated with the USACE, the Raleigh Field Office, and the North Carolina Wildlife Resources Commission (NCWRC).

Terms and Conditions – Loggerhead, Green, and Leatherback Sea Turtle (USFWS)

38. Beach compatible fill must be placed on the beach or in any associated dune system. Beach compatible fill must be sand that is similar to a native beach in the vicinity of the site that has not been affected by prior sand placement activity. Beach compatible fill must be sand consisting solely of natural sediment and shell material, containing no construction debris, toxic material, large amounts of rock, or other foreign matter. The beach compatible fill must be similar in both color and grain size distribution (sand grain frequency, mean and median grain size and sorting coefficient) to the native material in the Action Area. Beach compatible fill is material that maintains the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system. In general, fill material that meets the requirements of the North Carolina Technical Standards for Beach Fill (15A NCAC 07H .0312) is considered compatible.

39. During the nesting season (May 1 through November 15), no construction will be allowed on the beach, and no equipment may be placed and/or stored on the beach.

40. No permanent exterior lighting will be installed in association with this construction project, unless required by the U.S. Coast Guard. Temporary lighting will be allowed if safety lighting is required at any excavated trenches that must remain on the beach at night.

41. If the construction of the groin will be conducted during the period from April 1 to April 30, daily early morning surveys for early nesting sea turtles must be conducted. If the construction project will be conducted during the period from November 16 through November 30, surveys for late nesting sea turtles must be conducted. If nests are laid in the area of construction, the nests must be marked and avoided. Nesting surveys and nest marking must be initiated 65 days prior to construction activities or by April 1, whichever is later.

42. Visual surveys for escarpments along the Action Area must be made immediately after completion of construction, after sand maintenance events, and within 30 days prior to May 1 for two subsequent years after any construction or sand placement event. Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet must be leveled and the beach profile must be reconfigured to minimize scarp formation by the dates listed above. Any escarpment removal must be reported by location. The Service must be contacted immediately if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service or NCWRC will provide a brief written authorization within 30 days that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken must be submitted to the Service's Raleigh Field Office.

43. Staging areas for earth-moving equipment must be located off the beach during the early (April 1 through April 30) and late (November 16 through November 30) portions of the nesting season. Nighttime storage of earth-moving equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. All excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day. During any periods when excavated trenches must remain on the beach at night, nighttime sea turtle monitoring by the sea turtle permit holder will be required in the project area in order to further reduce possible impacts to nesting and hatchling sea turtles. Nighttime monitors will record data on false crawls, successful nesting, and any additional activities of nesting or hatchling sea turtles in the project area.

44. Sand compaction must be monitored in the area of sand placement immediately after

completion of the construction, after any sand maintenance event, and also prior to May 1 for two subsequent years after any construction or sand placement event. Out-year compaction monitoring and remediation are not required if the placed material no longer remains on the dry beach.

a. Within 7 days of completion of sand placement and prior to any tilling, a field meeting shall be held with the Service, NCWRC, and the USACE to inspect the Action Area for compaction, and determine whether tilling is needed.
b. If tilling is needed, the area must be tilled to a depth of 36 inches.
c. All tilling activity shall be completed prior to May 1.
d. Tilling must occur landward of the wrack line and avoid all vegetated areas that are 3 sf or greater, with a 3 square foot (sf) buffer around the vegetated areas.
e. If tilling occurs during shorebird nesting season (after April 1), shorebird surveys are required prior to tilling per the Migratory Bird Treaty Act.
f. A report on the results of compaction monitoring will be submitted to the Raleigh Field Office and NCWRC prior to any tilling actions being taken. An annual summary of compaction assessments and the actions taken will be submitted to the Service, as required in REPORTING REQUIREMENTS, below.
g. This condition will be evaluated annually and may be modified if necessary to address sand compaction problems identified during the previous year.

45. Daily sea turtle nesting surveys must be conducted by the permittee for three (3) full nesting seasons following construction if the groin structure remains in place. All nests from a point 3,200 feet west (updrift) of the groin (at approximately High Point Street) to a point 2,000 feet east (downdrift) of the groin must be marked for three (3) years post-construction. The survey area must be divided into three segments: Updrift Zone, Project Zone, and Downdrift Zone. The parameters listed in **Appendix B of the BO** shall be recorded for each crawl encountered on a daily survey. In addition, any obstructions (natural or man-made) encountered by the turtle and the turtle's response to that obstruction must be reported. These nests must be monitored daily till the end of hatching to determine whether those nests are eroded and whether the groin is a potential barrier to hatchlings moving off the beach and through the surf zone. This information will be provided to the Raleigh Field Office pursuant to the REPORTING REQUIREMENTS section, below, and will be used to periodically assess the cumulative effects of these projects on sea turtle nesting and hatchling production and monitor suitability for nesting. The USACE will notify the NCWRC and the Service immediately for remedial action.

46. A report describing the fate of sea turtle nests and hatchlings and any actions taken, must be submitted to the Raleigh Field Office following completion of the proposed work for each year when an activity has occurred (e.g. sand placement or groin construction). Please see REPORTING REQUIREMENTS below, for more information.

47. A post construction survey(s) of all artificial lighting visible from the adjacent beach (100 feet on either side of the groin must be completed by the permittee. Two surveys must be conducted of all lighting visible from the construction area by the permittee, using standard techniques for such a survey (**Appendix C of the BO**), in the year following construction. The first survey must be conducted between May 1 and May 15 and a brief summary provided to the Raleigh Field Office. The second survey must be conducted between July 15 and August 1. A summary report of the surveys, (include the following information: methodology of the survey, a map showing the position of the lights visible from the beach, a description of each light source visible from the beach, recommendations for remediation, and any actions taken), must be submitted to the Raleigh Field Office within 3 months after the last survey is conducted. After the annual report is completed, a meeting must be set up with the Applicant, county or municipality, NCWRC, USACE, and the Service to discuss the survey report, as well as any documented sea turtle disorientations in or adjacent to the project area.

Terms and Conditions – Piping Plover and Red Knot (USFWS)

48. All personnel involved in the construction or sand placement process along the beach shall be trained to recognize the presence of piping plovers and red knots prior to initiation of work on the beach. Before start of work each morning, a visual survey must be conducted along the ingress route and in the area of work for that day, to determine if piping plovers or red knots are present. If plovers or red knots are present in the work area, careful movement of equipment in the early morning hours should allow those individuals to move out of the area. If piping plovers or red knots are observed, the observer shall make a note on the Quality Assurance form for that day, and submit the information to the USACE and the Service's Raleigh Field Office the following day.

49. A bird monitoring plan must be developed to monitor piping plover, red knot, waterbirds, colonial waterbirds and other shorebirds during and after construction. Monitoring must be conducted for a minimum of three (3) full years past the completion of groin construction, or until the end of the shorebird nesting season (August 31) of the third year after construction, whichever is later. Post-construction monitoring may only be ceased after the review of at least three years' worth of data and approval by the USACE, USFWS, NCDCM, and NCWRC.
    a. The bird monitoring plan, including methods and a figure showing the proposed locations and extent of monitoring, must be submitted for review and approval to the USACE, USFWS, NCDCM, and NCWRC, at least 60 days prior to the anticipated start of construction.
    b. During construction, bird monitoring must be conducted weekly. For at least

three years after construction is completed, bimonthly (twice-monthly) bird surveys shall be conducted in all intertidal and shoreline areas from a point 3,200 lf west (updrift) of the groin (at approximately Highpoint Street) to a point just west of Skimmer Court on Holden Beach. All intertidal and supratidal unvegetated areas of the oceanfront, inlet shoulders, and sandy shoreline along the AIWW (in the vicinity of Shallotte Inlet and piping plover critical habitat unit NC-17) must be included. Field observations must be conducted during daylight hours, and primarily during high tide.

c. Shorebird identification, especially when in non-breeding plumage, can be difficult. The person(s) conducting the survey must demonstrate the qualifications and ability to identify shorebird species and be able to provide the information listed below. The bird monitoring plan should include the collection and reporting of the following:
    i. Date, location, time of day, weather, and tide cycle when survey was conducted;
    ii. Latitude and longitude of observed piping plover and red knot locations (decimal degrees preferred);
    iii. Any color bands observed on piping plovers or red knots or other birds;
    iv. Behavior (e.g., foraging, roosting, preening, bathing, flying, aggression, walking, courtship, copulation);
    v. Landscape features(s) where birds are located (e.g., inlet spit, tidal creeks, shoals, lagoon shoreline);
    vi. Habitat features(s) used by birds when observed (e.g., intertidal, fresh wrack, old wrack, dune, mid-beach, vegetation);
    vii. Substrata used by birds (e.g., sand, mud/sand, mud, algal mat); and
    viii. The amount and type of recreational use (e.g., people, dogs on or off leash, vehicles, kite-boarders).

d. All monitoring information shall be provided in standardized form on an Excel spreadsheet. Monitoring results shall be submitted (datasheets, maps, database) on standard electronic media (e.g., CD, DVD) to the Raleigh Field Office. Please see REPORTING REQUIREMENTS below, for more information.

Terms and Conditions – Seabeach Amaranth (USFWS)

50. Seabeach amaranth surveys must be conducted updrift and downdrift of the terminal groin in the Action Area, from a point 3,200 lf west of the groin (at approximately Highpoint Street) along Ocean Isle Beach to a point 2,000 lf east of the groin, for a minimum of three years after completion of groin construction. Surveys should be conducted in August of each year. Habitat known to support this species, including the upper edges of the beach, lower foredunes, and overwash flats must be visually surveyed for the plant. Annual reports should

include numbers of plants, latitude/longitude, and habitat type. Please see REPORTING REQUIREMENTS, below, for more information.

REPORTING REQUIREMENTS (USFWS)

An annual report detailing the monitoring and survey data collected during the preceding year (required in the above Terms and Conditions) and summarizing all piping plover, red knot, shorebird, seabeach amaranth, and sea turtle data must be provided to the Raleigh Field Office by January 31 of each year for review and comment. In addition, any information or data related to a conservation measure or recommendation that is implemented should be included in the annual report. The contact for these reporting requirements is:

Pete Benjamin, Supervisor
Raleigh Field Office
U.S. Fish and Wildlife Service
Post Office Box 33726
Raleigh, North Carolina 27636-3726
(919) 856-4520

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification must be made to the USFWS Law Enforcement Office below. Additional notification must be made to the USFWS Ecological Services Field Office identified above and to the NCWRC at (252) 241-7367. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

Tom Chisdock
U.S. Fish and Wildlife Service
160 Zillicoa St.
Asheville, NC 28801
828-258-2084

CULTURAL RESOURCES

51. If submerged cultural resources are encountered during the operation, work in the area shall cease and the USACE Wilmington District, Regulatory Division will be immediately notified so that coordination can be initiated with the Underwater Archeology Unit (UAU) of the Department of Cultural Resources. In emergency

situations, the permittee should immediately contact Mr. Nathan Henry at (910-458-9042), Fort Fisher, so that a full assessment of the artifacts can be made.

MISCELLANEOUS

52. Monitoring protocols for turbidity shall be implemented so as not to exceed the turbidity standard of 25 NTUs (Nephelometric Turbidity Units) as described in 15A NCAC 028.0200. Appropriate sediment and erosion control practices must be used to meet this standard. The monitoring protocols must be provided to the USACE, Wilmington Regulatory Field Office for review 30 days prior to project commencement.

53. The permittee shall implement the Inlet Management Plan, as presented in Chapter 6 of the FEIS and in Appendix G of this document, and comply with all requirements identified therein. All reports required by the Inlet Management Plan shall be timely submitted to the USACE.

54. Prior to any construction activities, and within 60 days of receipt of this authorization, the permittee shall provide the USACE proof of financial assurance submitted to the Coastal Resources Commission, in accordance with the provisions of NCGS 113A-115-1, as amended. The financial assurance may be in the form of a bond, insurance policy, escrow account, guaranty, local government taxing or assessment authority, a property owner association's approved assessment, or other financial instrument or combination of financial instruments that is adequate to cover the cost of implementing all of the following components of the inlet management plan:
    a. Long-term maintenance and monitoring of the terminal groin structure and down drift shorelines.
    b. Implementation of mitigation measures as described in the Inlet Management Plan and any permit conditions.
    c. Modification or removal of the terminal groin.

55. All reports and written notifications required by these permit conditions, including the CAMA permit conditions, shall be sent to the USACE c/o the following POC and address: Wilmington Regulatory Field Office, Attn: Mr. Tyler Crumbley, Wilmington District U.S. Army Corps of Engineers, 69 Darlington Ave., Wilmington, NC 28403, tyler.crumbley@usace.army.mil, (910) 251-4170.

56. To the extent that any permit attachments and plans conflict with the permit special conditions, the permit special conditions shall prevail.

Appendix A

The Corps received comments on the DEIS, FEIS and the Public Notice for the Section 10 and 404 permit application for the proposed action. Comments received on the DEIS and FEIS focused mainly on impacts to neighboring beach communities, the Delft 3D Model, economic analyses, and threatened and endangered species.

Many comments were received in regards to the content of the DEIS, which resulted in editorial and factual changes to the document. The comments on the DEIS and Public Notice for the Section 10 and 404 permit application were fully addressed and all comments and responses can be found in Appendix G of the FEIS and throughout the body of the FEIS.

All FEIS comments and responses to the comments are listed below:

A.1. Comment: In an email dated May 1, 2016, a citizen of Graham, North Carolina, stated that he is opposed to Alternative 5, "terminal groin construction. It is a hardened beach structure. It is a temporary solution which does not work in the long term. It is a waste of limited taxpayer funds. The allowance of hardened beach structures in NC is a political decision granted by the General Assembly in Raleigh. Beach hardened structure construction is in direct opposition to well proven coastal geology studies done on the NC coast that they do not work."

Response: Comment noted. The FEIS references multiple literature sources for evaluating the negative and positive impacts associated with the proposed project. Section 10 of this document also provides a discussion on the decision parameters that are under the control and responsibility of the USACE.

B.1. Comment: In a phone call on May 27, 2016, Mr. Thomas Blevins states that he is in favor of the project. His address is 478 East Third Street, Ocean Isle Beach. His home was once 4 streets back and is now ocean front.

Response: Comment noted.

<u>Comments from the North Carolina Wildlife Resources Commission (NCWRC) in a letter dated May 31, 2016:</u>

C.1. Comment: The NCWRC still has concern with several aspects of the project. Many of these concerns were presented in our reply to the EDIS (Dunn, 16 March 2015). In general, our agency believes projects that affect oceanfront beaches and natural inlet processes such as beach nourishment, inlet dredging, inlet relocation, and the construction of hardened structures on or along beaches may adversely affect sea turtle nesting areas, shorebird foraging and nesting areas, and ingress and egress within the inlet of fishery resources.

Response: The Corps consulted with USFWS and NMFS and all terms and conditions of the BO will be incorporated as special conditions in any authorization for this project. The terms and conditions of the BO would mitigate potential adverse effects to threatened and endangered species and shorebirds. The Corps also consulted with the NMFS HCD with regard to EFH impacts. No ingress or egress concerns were identified during coordination.

C.2. Comment: The DEIS includes projections of shoreline response from modeling. However it is difficult to incorporate outside factors, such as shoreline management activities on Holden Beach and other river/inlet channel manipulations, in these projections. These factors further complicate the ability to manage the dynamic barrier island system and thereby lead to concerns of impacts to wildlife and wildlife habitats. Impacts would not be limited to Ocean Isle Beach, but also affect shoreline profiles on Holden Beach, shoal, and sand spit formations within the inlet, and potential impacts to saltmarsh complexes associated with designated PNAs. The concern for the accuracy of the model's projection, including the intervals between nourishment events and estimated material volumes, in such a dynamic system is increased with the consideration of only long term erosion and not storm events. Although the model states nourishment events would only occur every 5 years, this does not take into consideration storm events that may trigger separate nourishment activities, further impacting inlet habitats and benthic invertebrate recruitment.

Response: There are no impacts to salt marsh complexes anticipated. Appendix C of the FEIS provides details on the calibration and verification of the model. Delft3D model is not used to predict the future since, in order to do so, the capability to predict anomalous weather and sea conditions would be needed. Through use of the model to evaluate all alternatives under the same data set, the effects of the alternatives on long term erosion can be evaluated. The need for nourishment events after storm events may still exist under all alternatives and to attempt to predict the intensity of a storm event and the effect it may have on the project area under any alternative is outside the scope of this evaluation.

C.3. Comment: The presence of hardened structures as well as changes in sediment transport will remove nesting and foraging habitat for several shorebird species as well as reduce forage opportunities by impacting benthic invertebrate populations through continued nourishment activities and insufficient recovery periods. This is exacerbated by allowing construction and nourishment activities during the month of April when shorebirds arrive to these areas. To avoid and minimize these impacts, any shoreline management activities should include a moratorium of April 1 - November 15. The importance of the month of April should be recognized by this project, particularly since critical habitat for piping plover is designated within the permit area. The FEIS states that some of the impact would be mitigated through the expansion of beach. However, it is unlikely any increase in shoreline west of the proposed structure would significantly increase colonial waterbird or shorebird habitat opportunities due to the influence of human activity.

Response: The Corps consulted with USFWS and in a letter dated August 6, 2015 the USFWS concurred with the Corps' effects determinations. All terms and conditions of the BO will be incorporated as special condition in any authorization for this project. The terms and conditions of the BO would mitigate adverse effects to threatened and endangered species and other shorebirds. During construction of the terminal groin, and for the life of the permit, all sand placement activities must be conducted within the winter work window (November 16 to March 31), unless necessitated by an emergency condition and allowed after consultation with the Service. A moratorium of shoreline activities from April 1 to November 15 of any year will be instituted as directed by and through consultation with USFWS. Other conditions of any Corps authorization include: Personnel involved in the construction or sand placement process along the beach shall be trained to recognize the presence of piping plovers and red knots prior to initiation of work on the beach. Before start of work each morning, a visual survey must be conducted along the ingress route and in the area of work for that day, to determine if piping plovers or red knots are present. If plovers or red knots are present in the work area, careful movement of equipment in the early morning hours should allow those individuals to move out of the area. If piping plovers or red knots are observed, the observer shall make a note on the Quality Assurance form for that day, and submit the information to the Corps and the Service's Raleigh Field Office the following day.

Additionally, a bird monitoring plan will be developed to monitor piping plover, red knot, waterbirds, colonial waterbirds and other shorebirds during and after construction. Monitoring will be conducted for a minimum of three (3) full years past the completion of groin construction, or until the end of the shorebird nesting season (August 31) of the third year after construction, whichever is later.

C.4. Comment: With specific regard to the use of the area by piping plover, the FEIS notes that there are many "no data" entries. It should be noted that this should not be interpreted as no presence or use of the area by the species, but rather the inability to adequately survey the area. This can be attributed to the majority of the area being in private ownership and the inability to access or the need for more regular, standardized surveys by trained personnel. It should not be assumed that existing monitoring is adequate or that increased monitoring can be handled by state and federal agencies.

Response: The Corps consulted with USFWS and NMFS and all terms and conditions of the BO will be incorporated as special condition in any authorization for this project. The terms and conditions of the BO would mitigate adverse effects to threatened and endangered species and shorebirds.

C.5. Comment: Continued monitoring throughout the duration of the project should be done to determine if increases in false crawls occur or if overall nesting decreases. If significant changes occur, measures should be made to mitigate the loss. Any hatchlings that emerge from nests could be disoriented from lighting associated with the groin. Therefore, if the structure is constructed, lighting should be done to minimize this impact, especially after hatchlings begin to emerge.

Response: The Corps consulted with USFWS and NMFS and all terms and conditions of the BO will be incorporated as special conditions in any authorization for this project. The terms and conditions of the BO would mitigate adverse effects to threatened and endangered species and shorebirds. Within the Terms and Conditions of the BO, it is stated that no permanent exterior lighting will be installed in association with this construction project, unless required by the U.S. Coast Guard. Temporary lighting will be allowed if safety lighting is required at any excavated trenches that must remain on the beach at night. This condition will be included in any authorization.

C.6. Comment: The FEIS states the design of the terminal groin would be "leaky" in nature and that the structure would not significantly affect juvenile and larvae transport in the inlet complex. This statement is based on the assumption that in time, the beach will migrate to the terminus of the structure and essentially the groin will be buried under the beach and not project into the ocean. We still have concern that juvenile and larvae transport, especially for Atlantic and shortnose sturgeon, will be impacted until the groin is buried or continued if the structure is never covered.

Response: The preferred alternative is not expected to substantially impact larval fish transport. Given the relative short length of the proposed terminal groin at Ocean Isle Beach with the combination of beach fill west of the structure, minimal impacts associated with larval transport are expected. As described in Chapter 3 of the FEIS, the fillet of the terminal groin will be constructed with beach compatible material immediately following construction of the groin, which will effectively extend the dry beach shoreline seaward approaching the end of the terminal groin. The magnitude of indirect impacts to these higher level trophic species may be mitigated by the large area of habitat available beyond the nourishment site. Furthermore, peak larval recruitment periods for most benthic species are avoided by disposal typically occurring during winter months. The Corps consulted with USFWS and NMFS and all terms and conditions of the BO will be incorporated as special conditions in any authorization for this project. The terms and conditions of the BO would mitigate adverse effects to threatened and endangered species, including Atlantic and shortnose sturgeon.

C.7. Comment: The FEIS states the project will be monitored for success and if necessary mitigation for negative impacts would be implemented. Although the FEIS addresses mitigation for some impacts, it is unclear how impacts will be measured and mitigation implemented for numerous impacts to biological resources. It should be further noted that if nourishment activities increase as a direct relationship to groin construction, for either Ocean Isle Beach or Holden Beach, impacts to wildlife resources are increased. Mitigation should be considered for these impacts with creation or protection of similar habitat types.

Response: Monitoring and mitigation measures are described in Chapter 6 of the FEIS, additionally, all Reasonable and Prudent Measures, and Terms and Conditions of the USFWS and the NMFS BOs will be incorporated as special conditions under any authorization. Monitoring and mitigation requirements are part of the USFWS BO including escarpments, turtle monitoring, and bird surveys. Post construction monitoring may only be ceased after the review of at least three years' worth of data and approval by the Corps, Service, NCDCM, and NCWRC.

C.8. Comment: If it is determined that the project can be permitted, careful consideration should be given to the following: 1) Any shoreline management activities should be done outside April 1 - November 16 of any year to avoid impacts to nesting shorebirds and sea turtles; 2) Standardized surveys for piping plover, red knot, and other beach-dependent birds should be conducted by a contractor trained in bird identification and surveys before, during, and after pipeline placement and removal. Monitoring should be continued for a period of time post-construction to assess habitat impacts and resource use; 3) In a continued effort to protect nesting shorebird habitat each year, potential nesting areas could be marked each March with posts, signs, and flagged string tied between posts. Posted areas would be maintained through August 15th, thereafter, posts and other materials could be removed. Further information can be obtained via contact with the NCWRC; 4) A periodic mapping assessment of the eastern end of Ocean Isle Beach and at the inlet would be a benefit in determining actual sediment transport and vegetation establishment after groin construction. This would help measure the effectiveness of the groin to gauge response for Ocean Isle's shoreline management and provide data for other terminal groin projects.

Response: Section 7 of this document describes the coordination with the USFWS and Section 10 of this document describes the impacts and mitigation measures to threatened and endangered species and other fish and wildlife values. A moratorium of shoreline activities from April 1 - November 15 will be a condition of the permit. Bird monitoring is required per the terms and conditions of the USFWS' BO. The BO does not include any conditions that require the applicant to post the site as shorebird nesting areas. The baseline conditions of a number of biological resources are reported in Chapter 4 of the FEIS and designated as Shallotte Inlet Habitat Mapping Area (Figure 6.1. of the FEIS). Subsequent habitat mapping efforts will be utilized to assess the extent of change to these habitats within the designated boundary following construction activities.

<u>Comments from the North Carolina Division of Coastal Management (NCDCM) in a letter dated June 3, 2016:</u>

D.1. Comment: In regards to DEIS Comment - pg. 17: Please provide additional information on the frequency at which sand has been placed on the beach, including the 2014 activities, and the volume of materials associated with each specific project. It does not appear that this item was addressed as a specific response item in

Appendix G. Please provide the additional requested information as a response item in Appendix G.

Response: Page 17 of the FEIS states that the initial construction of the federal project was performed in 2001 and involved 1,866,000 cy of material. Since that time, the project has been maintained three times- 2006 (449,400 cy), 2010 (509,200 cy), and 2014 (~800,000 cy). In addition, the east end of OIB (beyond the federal project footprint) received material in 2006 (155,000 cy). Table 2.1 on page 18 of the FEIS depicts these events and associated volumes.

D.2. Comment: DCM reply to FEIS (see response item 74 in Appendix G): For all Alternatives, the document assumes a 3-year federal project volume of 408,000 cy, despite the fact that the last three projects have all exceeded ~450,000 cy. This lower average volume is due to the skipped project in 2004 (which according to the Town, wasn't needed), which therefore lowers the overall average per-event average. The project was initially constructed in 2001. In 2007, 449,400 cy of material was placed between Stations 10+00 and 72+00. In 2010, 509,200 cy of material was placed west of station 10+00 with federal funds. In 2014, ~800,000 cy of material was placed. The lower average volume (408,000) artificially increases the risk of damage in Alt. 1-3, as shown by the assumed land and property losses in 2015 that did not actually occur. DCM recommends this information be updated to reflect more current data.

Response: Over the 13 year period from 2001 to 2014, a total of 1,758,000 cy was placed within the limits of the Federal project using a combination of federal and non-federal funds. This represents an average annual placement of 135,300 cy/yr. or 405,900 cy every 3 years. This 3-year average was adjusted to account for the volume of material placed between 10+00 and 17+00 in 2007 resulting in the 408,000 cy/3-years used in the formulation of all alternatives that included a beach fill component. The periodic nourishment rate did not have a direct impact on the assessment of potential damages, as damages were based on the continued movement of the erosion scarp on the east end of the island. The movement of the erosion scarp was documented for the period September 1999 to May 2010 using LiDAR data. Since this time period included the initial construction of the federal project in 2001 and the 2007 and 2010 periodic nourishment events, the impact of nourishment on the movement of the erosion scarp is implicitly included in the rate of scarp movement used in the analysis. Even though some of the losses projected for 2015 did not occur, the condition of the sandbag revetment fronting these proprieties did suffer damage during Hurricane Matthew and appear to be on the verge of failure. The LiDAR data actually extends to May 2010. Movement of the scarp post May 2010 would have been stopped by the existing sandbag revetment.

D.3. Comment: Assumptions are made on sandbag failure due to events in 2005, but shoreline position data stops in 2009-2010 and does not include data since 2010. This post-2010 information should be provided.

Response: As mentioned above, the sandbag revetment on the east end has experienced considerable damage. The period of time used to assess the effectiveness of sandbags was adequate to characterize the potential for sandbag failure.

D.4. Comment: Placement of sand on the Town's east end due to the federal navigation project is only mentioned in passing and is not addressed in any detail. DCM suggests including a discussion of this project in a manner consistent with that of the other projects.

Response: Very little data is available for the disposal of navigation maintenance material on the east end of Ocean Isle Beach by the USACE. Estimated volumes placed along the east end are included in the FEIS and a brief assessment of the effectiveness of these disposal operations included in the discussion.

D.5. Comment: DCM reply to FEIS (see response item 76 in Appendix G). DCM recommends that the document provide more detailed information on the cost of the "non-federal" support. Specifically, estimated separate costs to the Town and the State of North Carolina should be provided

Response: The allocation of implementation cost for each alternative is explained in Appendix B of the FEIS. The $43.19 million federal share for Alternative 1 as well as Alternatives 2 and 3, is the projected 30-year cost for periodic nourishment within the limits of the federal project. This represents 65% of the cost to place material anywhere between stations 10+00 and 181+00 (limits of federal project). Any implementation cost of an alternative associated with the placement of material outside the federal project limits were allocated to non-federal interest. In the case of Alternatives 4 and 5, the cost to nourish the federal project varied depending on the impacts of the alternative on nourishment needs within the limits of the federal project. In both instances where any material that would be placed within the federal project limits, an assumption was made that the federal government would continue to contribute 65% of the cost for this material with the non-federal interest contributing 35% of the cost. Since the amount of the nourishment costs that would be provided by the State varies with each nourishment project, allocation of a specific costs to the State is not possible.

D.6. Comment: DCM reply to FEIS (see response item 79 in Appendix G). Alternative 1 still does not adequately explain the assertion that the 155 buildable parcels and 25 homes are vulnerable to erosion and loss in the next 30 years under current management practices. Figure 3.1 does not clearly show the 155 parcels identified as being at risk. Additionally, Figure 3.1 should be updated to reflect actual 2015 conditions. The 2015 scarp predicted the loss of 11+ homes which are still standing and protected by sandbags as of the date of this letter. Also, the assumption that sandbags will fail within 5 years is not substantiated by recent history - given that the sandbags in the area were installed between 2005 and 2009. DCM recommends additional revisions to the presentation of this data.

Response: Additional information regarding the number of parcels susceptible to erosion has been provided in Appendix D of this document. With regard to the sand bag revetments: four homes were lost east of Shallotte Blvd. between Sep 2007 and June 2008 (Google Earth Photos). Of the 11 homes still standing east of Shallotte Blvd and south of 3rd St., eight (8) are situated behind partially or totally failed sandbag revetments (2014 Google Earth Photo).

D.7. Comment: DCM reply to FEIS (see response item 81 in Appendix G). DCM recommends that the document provide more detailed information on the coast of the "non-federal" support. Specifically, estimated separate costs to the Town and the State of North Carolina should be provided.

Response: Only the total non-federal share can be provided since the State share varies with each nourishment project.

D.8. Comment: DCM reply to FEIS (see response item 82 in Appendix G). The document assumes "potential damages would begin in 2015" and continue. As of the date of this letter, these damages have not occurred. DCM recommends additional revisions to of this data to reflect actual current conditions.

Response: Even though some of the losses projected for 2015 did not occur, the condition of the sandbag revetment fronting these proprieties did suffer damage during Hurricane Matthew and appear to be on the verge of failure. The LiDAR data actually extends to May 2010. Movement of the scarp post May 2010 would have been stopped by the existing sandbag revetment. Additionally, as described above, four homes were lost east of Shallotte Blvd. between Sep 2007 and June 2008 (Google Earth Photos). Of the 11 homes still standing east of Shallotte Blvd and south of 3rd St., eight (8) are situated behind partially or totally failed sandbag revetments (2014 Google Earth Photo).

D.9. Comment: DCM reply to FEIS (see response item 83 in Appendix G). DCM offers the following comments and recommendations to the response to this item: 1) The document did not make any changes to the section for Alternative 3, and simply stated that the depth of the channel influences sediment transport and would not affect Holden Beach. Further supporting documentation on this statement is requested. 2) As was stated in a response above, the impacts of Alternatives 1 - 3 appear flawed and overstated due to the assumption of a maximum average federal project volume of 408,000 cy, when the last three projects (2007, 2010 and 2014) have exceeded that volume. DCM recommends this information be updated to reflect more current data. 3) It is unclear to how the expected volumetric loss of 140,000 cy/year east of Station 30+00 was derived, when the Engineering Report calculates an average loss of 92,000 cy from 2001 to 2013 and a -88,000cy annual rate of change from 2007 and 2010 (Tables 3.2 and 3.4, Appendix B). 4) The document appears to have changed some the figures in the FEIS relative to the DEIS. For example, the overall coast of Alternative 3 was reduced from $115.5M to $108.77M, and the non-federal interest balance was reduced from $72.3M to $65.58M. Federal share percentage was increased to 39.7% from 37.4% and a non-federal share was reduced from 62.6% to 60.3%. Please describe the reason behind these changed values. 5) The volume losses described for Holden Beach in Alternative 5 (pg. 40) have changed from original estimates in the DEIS. The justification for these changes should be detailed.

Response: The results obtained using the updated Delft3D model for Alternative 3 along the west end of Holden Beach were the same as the results obtained under Alternative 1. Therefore, based on these results, Alternative 3 would not have any significant impact on volume losses from the west end of Holden Beach. As discussed in Appendix B of the FEIS, the volume loss east of station 30+00 under Alternative 3 was based on the simulated difference in volume loss from this area between Alternatives 1 and 3. The measured volume loss under existing conditions averaged 91,000 cy/yr between 2001 and 2013. The Delft3D model indicated volume losses from this area would be 54% greater under Alternative 3 versus Alternative 1. Therefore, the expected volume loss under Alternative 3 was computed by multiplying the measure rate of 91,000 cy/yr by 1.54 to yield 140,000 cy/yr. After releasing the DEIS, the Delft3D model was run to simulate the channel relocation Alternative (Alternative 4). Due to changes in the model set-up associated with updated bathymetry, the new model setup was used to reevaluate all of the alternatives. As a result, the projected nourishment requirements for Alternative 3 were reduced from 436,000 cy every two years to 384,000 cy every two years. As a result, the total 30-year cost for Alternative 3 was reduced in the FEIS compared to the DEIS. However, the federal share of the nourishment cost was held constant at $43.19 M, which is the cost of nourishing the existing federal project over 30 years. By keeping the federal costs constant, the percent of the federal share of the total cost increased. The changes in the volume losses off the west end of Holden Beach between the DEIS and FEIS were also due to the difference in the model results obtained for Alternative 5 with the revised model setup.

D.10. Comment: The response to this item (see response item 93 in Appendix G) indicates that Table 3.11 provides economic impacts with all five studied alternatives. It does not seem reasonable that long-term erosion damages and response costs would be $0 for the alternatives of beach nourishment, channel relocation, and a 750' terminal groin. In DCM's experience, damages to properties and structures still may occur following implementation of a beach nourishment or channel relocation, resulting in additional costs. It is also uncertain if resulting monitoring and possible mitigation costs are factored into these costs estimates. DCM recommends additional clarification on this issue.

Response: While damages to structures and properties may still occur under all alternatives, the comparison of the economic impact of the alternatives was based on the costs to implement each alternative and is the equivalent average annual cost for all alternatives. The equivalent average annual cost is a means of comparing costs of various actions associated with each management alternative that would be implemented at different times during the analysis period. One way to interpret the equivalent average annual cost is to consider the amount of money one would have to invest each year at a given interest rate in order to pay for the estimated 30-year cost of the alternative. This comparison allows for equal costs analysis without attempting to predict future storm or discrete events that resulted in damages to properties. Monitoring and mitigation are not factored into these cost estimates.

D.11. Comment: The answer provided for this item (see response item 94 in Appendix G) indicates that the preferred alternative would "relieve the necessity of sandbag revetments in the project area." While DCM acknowledges that the design of the preferred alternative is intended to protect properties within the project area, we suggest adding a statement that also acknowledges that in response to erosional events not associated with the terminal groin (for example erosion related to a storm or hurricane), individual property owners may still choose to pursue sandbag stabilization of their properties after groin construction. Therefore, it is suggested that the document contain a statement of this possibility.

Response: Suggestion noted. We acknowledge that sandbags may still be considered in response to storm events.

D.12. Comment: As indicated in response item 104 in Appendix G, the Inlet Management Plan for this project now includes baselines and thresholds for Stations 375-400 on Holden Beach and from the inlet to Station 5 on Ocean Isle Beach. The plan also includes commitments by the Town to cover the cost of monitoring should the Corps of Engineers be unable to perform their traditional monitoring efforts for any reason. The Division finds these additions to the Inlet Management Plan to be satisfactory. However, DCM is concerned about the use of the March 1999 shoreline position as the mitigation threshold for the Ocean Isle Beach Sand Spit. The DCM questions the use of the 1999 shoreline configuration, which appears to be the most landward extent of the existing shoreline surveys, to establish mitigation thresholds. DCM requests that the applicant provide additional information on how this shoreline position was chosen.

Response: The March 1999 spit shoreline was selected because it was the last image available that preceded the initial construction of the federal project. The changes that occurred to the spit after construction of the federal project were primarily due to the impacts of the Shallotte Inlet borrow area thereby representing the last natural shoreline before the project was implemented which manipulated the inlet and oceanfront shoreline

<u>Comments from Audubon North Carolina in a letter dated May 31, 2016:</u>

E.1. Comment: The FEIS fails to cite the applicable, most recent scientific literature and fails to accurately describe the impacts a terminal groin, beach renourishment, and inlet channelization would have on Shallotte Inlet and adjacent areas. Some of the impacts that are insufficiently addressed are the narrowing of downdrift oceanfront beach, loss of sediment from the inlet system, impacts to spits at ends of adjacent islands, loss of critical wildlife habitat, and cumulative impacts of the alternatives.

Response: The list of literature cited is provided in the FEIS. The Corps believes that the environmental impacts of the proposed terminal groin on beach nourishment, inlet dynamics, and adjacent beach areas and cumulative impacts are appropriately and accurately described in the FEIS within chapters 3 and 5 based on the best available science. The wildlife habitat impacts were also described within the Biological and Essential Fish Habitat assessments which were presented to the resource agencies during coordination.

E.2. Comment: The FEIS forecasts a five-year interval for beach renourishment for the alternative that includes a terminal groin (Alternative 5). Despite the well-known downdrift impact of terminal groins, the FEIS does not address the likelihood that in response to the terminal groin, the beach will narrow farther to the west and require additional and more frequent beach renourishment over the years. The proposed five-year interval for beach renourishment is also questionable given that Wrightsville Beach, Masonboro Island, Mason Inlet, southern Figure 8 Island, Oregon Inlet, and Ft. Macon, just to name a few, are dredged and replenished more frequently than five-year intervals. The near certainty that Ocean Isle Beach will need to mine sand from Shallotte Inlet and replenish the downdrift beach on Ocean Isle Beach more frequently than every five years has not been accurately assessed in the FEIS.

Response: Water circulation along the up-drift side of the structure would be altered during the construction and immediately upon completion of the structure. However, long term alteration of currents and circulation would be minimized by the construction of the fillet behind the structure and the proposal for the groin to be a “leaky” structure. In the event that the terminal groin adversely affects the nearby shorelines, the applicant will be required to alter the height and/or the configuration of the terminal groin or remove the terminal groin in order to mitigate for the adverse effects. The comparison of other inlets with regard to their dynamics on predicting the need for a more frequent nourishment cycle at Ocean Isle Beach is not appropriate. The modeling efforts conducted for the EIS conclude that a less frequent nourishment schedule will be needed for the preferred alternative than would be needed for all the other alternatives. The rubblemound portion of the terminal groin would be constructed with loosely placed armor stone on top of a foundation mat or mattress and would have a crest elevation of +4.9 feet NAVD. The loose nature of the armor stone was designed to facilitate the movement of littoral material through the structure while the relative low crest elevation of +4.9 feet NAVD would allow some sediment to pass over the structure during periods of high tide. The inlet dynamics of any one inlet system vary to such a degree that comparisons that draw definite conclusions based on structure type and location cannot be relied upon. Therefore the calibrated modeling results specifically for Shallotte Inlet have been used to determine the likely shoreline response of all the proposed alternatives.

E.3 Comment: The FEIS cites Oregon Inlet, NC as an example of a successful terminal groin project that has not "caused adverse impacts to the shoreline" (p. 177). The FEIS relies exclusively on one source—Overton (2011) and personal communications with Overton—to make this assertion. Recent and relevant literature is available, and the conclusions are different than those cited in the FEIS. To minimize impacts of the Oregon Inlet terminal groin on the downdrift shoreline of Pea Island, sediment from routine Oregon Inlet channel dredging has been placed either directly on the Pea Island beach or in shallow nearshore disposal area near northern Pea Island (Riggs and Ames 2011). Human efforts have only temporarily slowed the process of shoreline recession in a small portion of northern Pea Island by the regular addition of dredged sand at a very high cost, but each new beach nourishment project has quickly eroded away (Riggs and Ames 2009, Riggs et al. 2009). Based on several studies, the data strongly suggests that the terminal groin itself is contributing to the accelerated erosion and shoreline recession problems on Pea Island (Riggs and Ames 2003, 2007, 2009; Riggs et al. 2008, 2009; Mallinson et al. 2005, 2008, 2010; Culver et al. 2006, 2007; Smith et al. 2008).

Response: Any direct comparison of the Pea Island terminal groin to the one proposed for the east end of Ocean Isle Beach would be inappropriate due the difference in scale of the physical characteristics of the two inlets and the littoral environment at both sites. In this regard, the littoral climate in the Oregon Inlet area produces gross sediment transport rates of the order of 2.5 million cubic yards/year compared to sediment transport rates of around 500,000 cubic yards/year for Ocean Isle. In terms of physical attributes, Oregon Inlet is about three times as wide as Shallotte Inlet and has a tidal prism that is an order of magnitude greater than the tidal prism of Shallotte Inlet. As stated above, the inlet dynamics of any one inlet system vary to such a degree that comparisons that draw definite conclusions of success or failure based on structure type and location cannot be relied upon. Therefore the calibrated modeling results specifically for Shallotte Inlet have been used to determine the likely effects of all the proposed alternatives.

E.4. Comment: In addition to impacts on downdrift shorelines, hard structures at inlets permanently remove sand from the inlet system, reducing or eliminating shoal systems from affected inlets (Pilkey et al. 1998) and accelerating the loss of saltmarsh in the vicinity of the inlet (Hackney and Cleary 1987). The loss of saltmarsh at Shallotte Inlet would have significant negative impacts on fisheries, other wildlife, recreation, small businesses, and the local economy. These impacts and the loss of saltmarsh resulting from removal of sand from Shallotte Inlet have not been assessed for the preferred or other alternatives in the FEIS.

Response: Chapter four of the EIS describes the Affected Environments. The locations of saltmarsh communities are strictly relegated to the sound-sides of Ocean Isle Beach and Holden Beach. The lack of saltmarsh communities within the affected environment of the proposed action coupled with the design and monitoring of the structure to facilitate sand bypass will help to mitigate possibility of eliminating shoal systems within Shallotte Inlet. Consultation with the appropriate resource agencies (USFWS, NMFS) has been concluded and RPMs and Terms and Conditions of the associated BOs will be incorporated into any authorization.

E.5. Comment: The FEIS also fails to address the cumulative impacts of sand mining and the proposed terminal groin at Shallotte Inlet on the adjacent downdrift beach. The regular removal of sand from Shallotte Inlet and the proposed terminal groin at the east end of Ocean Isle Beach would disrupt the longshore transport of sand and potentially threaten Ocean Isle Beach—the adjacent downdrift shoreline—and the real estate thereon.

Response: Modeling, as presented in Appendix B of the FEIS, indicates that there will be no long term adverse effects to the Ocean Isle Beach shoreline. Additionally monitoring of the downdrift shoreline will indicate if there is a need for adaptive management required by the conditions of the DA permit. The CSDRP maintenance cycle is currently every 3 years. With the construction of the terminal groin alternative, the CSDRP maintenance cycle is expected to decrease to one event every 5 years thereby reducing impacts within the dredged area and the placement area to nesting sea turtles, shorebirds (nesting, resting, and foraging), infaunal communities, etc. In addition, with dredging only occurring approximately every 5 years (rather than every 3 years), the infaunal community within the footprint of borrow area within Shallotte Inlet would have more time to recover and there would be less frequent impacts to larval, juvenile, and adult finfish. Discussions on cumulative impacts for each proposed alternative are provided in Chapter 5 of the EIS.

E.6. Comment: There are at least 100 published studies that address the impacts of terminal groins on inlets, beaches, and natural resources. The majority (78%) of peer-reviewed literature we collected regarding the impacts of hard structures at inlets concluded that terminal groins do not function in the manner presented in the FEIS and cause more harm than good. The wealth of literature on the impacts of terminal groins is not discussed nor cited in the FEIS.

Response: The six citations suggested by Audubon North Carolina (Nelson 1985, Van Dolah et. al 1994, Levison and Van Dolah 1996, NCDENR 2010, Overton 2011, and Overton pers. comm.) were added to the FEIS and utilized in analyzing the alternatives. The State of North Carolina's (NCDENR 2010) Terminal Groin study was also cited, as the function of the study was to evaluate the impacts of terminal groins, and therefore by virtue of incorporating the findings of this study, the relevant literature has been incorporated. Specifically, the FEIS cites the CEC Terminal Groin Study. Also cited is the Olsen Associates, Inc. numerical model study that investigated larval transport off Bald Head Island in response to their proposed terminal groin which would result in minimal impacts associated with larval transport.

E.7. Comment: Loss or degradation of habitat, including that associated with coastal engineering projects, is identified as a primary threat in all shorebird conservation and management planning documents, including those addressing Piping Plovers and Red Knots. The cumulative impacts of the loss and degradation of habitats that are essential to inlet-dependent wildlife jeopardizes the recovery of federally-listed species, threatens the existence of federally-listed species, and contributes to the decline of state-listed species, none of which are evaluated in the FEIS.

Response: Consultation with the appropriate resource agencies (USFWS, NMFS) has been concluded. The proposed project may affect and is likely to adversely affect the piping plover and red knot. The applicant will be required to comply with all terms and conditions of the USFWS' BO dated August 6, 2015. All terms and conditions of the BO will be incorporated as special conditions of any Corps authorization. The USFWS' BO also includes measures to minimize impacts to migratory shorebirds in the project area.

E.8. Comment: Peterson et al. (2014) monitored the recovery of a sandy beach community for 3-4 years following nourishment and documented that haustoriid amphipods (small crustaceans) and Donax spp. had reduced densities for 3-4 years following nourishment, E. talpoida had lower densities for 1-2 years following nourishment, and ghost crabs had lower abundances for four years...For all alternatives, beach nourishment is proposed at an interval ranging from 2-5 years. Historically, Ocean Isle Beach was nourished every three years under the coastal storm damage reduction project. For the preferred Alternative 5, the FEIS states that nourishment will occur every five years. However, at inlets where terminal groins were constructed, the beach nourishment cycle is every 1-4 years (Riggs et al. 2009, Riggs and Ames 2011, Pietrafesa 2012). Pea Island was renourished every year from 1990-2004, and Fort Macon was renourished every 2-6 years from 1973-2007 (Pietrafesa 2012). If some species of the infaunal community recover in 3-4 years, the cumulative impact to the infaunal community due to nourishment at such sites is that the community cannot recover before the next nourishment cycle. In some cases, local extinction of benthic species has occurred (Colosio et al. 2007).

Response: Comment noted. The cumulative impacts are appropriately and accurately described in the FEIS within chapters 3 and 5.

E.9. Comment: The FEIS fails to recognize that if nourishment occurs every two years (Alternative 3), some of the infaunal community will not recover, which will negatively impact birds and fishes that feed on these species. Instead, the FEIS states that the implementation Alternative 3 would provide a positive impact to shorebirds since there will be an increase in dry beach width (p. 165). Birds will not benefit from an increased dry beach width because birds using the oceanfront beach only use the intertidal zone for foraging and nourishment does not increase the width of the intertidal zone.

Response: The CSDRP maintenance cycle is currently every 3 years. With the construction of the terminal groin alternative, the CSDRP maintenance cycle is expected to decrease to one event every 5 years thereby reducing impacts within the placement area to nesting sea turtles, shorebirds (nesting, resting, and foraging), infaunal communities, etc. In addition, with dredging only occurring approximately every 5 years (rather than every 3 years), the infaunal community within the footprint of borrow area within Shallotte Inlet would have more time to recover and there would be less frequent impacts to larval, juvenile, and adult finfish. Discussions on cumulative impacts for each proposed alternative are provided in Chapter 5 of the EIS.

E.10. Comment: …though timing of activity is important to avoid periods of larval recruitment, all work is assumed to take place within existing environmental windows. The potential for additional impacts both from more frequent nourishments and out-of-season nourishments should be addressed by the FEIS.

Response: The proposed alternative of a terminal groin is expected to reduce the number of nourishments, not increase frequency.

E.11. Comment: The modeling reported for Alternative 5 indicates that a significant amount of sediment would be lost from the system, resulting in the loss of habitat, primarily low-energy shoals and sandbars which provide habitat for a variety of benthic invertebrates that are consumed by shorebirds and fishes. Despite this, the FEIS preferred Alternative (5) and most other alternatives assert few impacts on infauna, and impacts that are acknowledged are marginalized.

Response: A complete discussion of the sediment budget and associated modeling parameters and results is located in Appendix B. With the construction of the terminal groin alternative, the CSDRP maintenance cycle is expected to decrease to one event approximately every 5 years thereby reducing impacts within the placement area to shorebirds (nesting, resting, and foraging), infaunal communities, etc. In addition, with dredging only occurring approximately every 5 years (rather than every 3 years), the infaunal community within the footprint of borrow area within Shallotte Inlet would have more time to recover and there would be less frequent impacts to larval, juvenile, and adult finfish. Discussions on cumulative impacts for each proposed alternative are provided in Chapter 5 of the EIS.

E.12. Comment: In its treatment of impacts to the infauna, the FEIS relies nearly exclusively on outdated literature that is generally not peer-reviewed, and it omits the many recent, peer-reviewed scientific papers that are available on the subject. Peterson and Bishop (2005) suggested that weaknesses in nourishment studies are due to studies being conducted by project advocates with no peer review process and the duration of monitoring being inadequate to characterize the fauna before and after nourishment. Thus, uncertainty surrounding biological impacts of nourishment can be attributed to the poor quality of monitoring studies, not an absence of impacts.

Response: The list of literature cited is provided in the FEIS. The Corps believes that the environmental impacts of the proposed terminal groin on beach nourishment, inlet dynamics, and adjacent beach areas and cumulative impacts are appropriately and accurately described in the FEIS within chapters 3 and 5 based on the best available science. The wildlife habitat impacts were also described within the Biological and Essential Fish Habitat assessments which were presented to the resource agencies during coordination. The FEIS does cite the Olsen Associates, Inc. numerical model study that investigated larval transport off Bald Head Island in response to their proposed terminal groin which showed the potential for minimal impacts associated with larval transport.

E.13. Comment: The FEIS does not address the impacts to sea turtles should beach renourishment intervals turn out to be similar to those at other North Carolina inlets with hardened structures, rather than at the five-year intervals it forecasts. Nesting activity on nourished beaches decreased for one to three years following a nourishment event due to changes in the sand compaction, escarpment, and beach profile (NMFS and USFWS 1991, Steinitz et al. 1998, Trindell et al. 1998, Rumbold 2001, Brock et al. 2009). The FEIS also does not address the impacts to sea turtle nesting should the east end of Ocean Isle Beach experience downdrift erosion that would narrow the beach west of the groin where nesting occurs.

Response: As stated above, the inlet dynamics of any one inlet system vary to such a degree that comparisons that draw definite conclusions regarding nourishment interval cannot be relied upon. Consultation with the appropriate resource agencies (USFWS, NMFS) has been concluded and RPMs and Terms and Conditions of the associated BOs will be incorporated into any authorization. The USFWS agreed that the project is not likely to adversely affect the hawksbill sea turtle and the West Indian manatee, therefore those species and their habitats are not discussed in the BO. The proposed project may affect and is likely to adversely affect the loggerhead, leatherback, Kemp's Ridley, and green sea turtles. The applicant will be required to comply with all terms and conditions of the USFWS' BO dated August 6, 2015. All terms and conditions of the BO will be incorporated as special conditions of any Corps authorization. NMFS also concurred that the project is not likely to adversely affect threatened and endangered sea turtles. A hopper dredge will not be used during construction, which would minimize impacts to threatened and endangered aquatic species, including sea turtles.

E.14. Comment: Fishes would be negatively impacted by the construction of a terminal groin and the subsequent beach nourishment projects at Shallotte Inlet in the following ways: 1) the groin would interrupt larval transport through the inlet, therefore impacting recruitment; 2) the native fish community would be replaced with a completely different structure-associated fish community; and 3) surf zone fishes would suffer from direct mortality.

Response: Chapters 5 of the FEIS provide a complete description of the potential effects and these impacts have been considered in our public interest assessments and effects determinations to species and their habitats. Consultation with the appropriate resource agencies (USFWS, NMFS) has been concluded and RPMs and Terms and Conditions of the associated BOs will be incorporated into any authorization. The project would occur in EFH, but impacts would be minimal and temporary. The proposed project will include dredging in Shallotte Inlet. By letter dated January 21, 2015, the Corps coordinated with the NMFS in accordance with the Magnuson-Stevens Fishery Conservation Management Act. The Corps determined that the proposed project would adversely affect EFH but the effects would be temporary and due largely to the temporary suspension of sediments in the water column at the excavation and nourishment site. In a letter dated May 31, 2016, NMFS stated that the expected activity is not expected to adversely impact EFH and they offered no EFH Conservation Recommendations.

In order to minimize impacts to EFH and the aquatic ecosystem, the permit will be conditioned to require a work moratorium for April 1 through November 15 to minimize environmental impacts and provide protections for seasonal migrations of fish and protected species.

E.15. Comment: If the base of the food chain is absent or largely absent due to nourishment activities every two years, then the organisms that consume them, like birds and fishes, will not be present either. The FEIS fails to make this connection. Alternatives 3, 4, and 5 as presented in the FEIS would negatively impact birds, as well as infauna, fishes, and sea turtles.

Response: The Corps determined that this connection has been considered adequately in the FEIS and impacts to nearshore fauna and infauna will not cause substantial adverse effects to the food chain. Consultation with the appropriate resource agencies (USFWS, NMFS) has been concluded and RPMs and Terms and Conditions of the associated BOs will be incorporated into any authorization.

E.16. Comment: The FEIS omits the vast majority of the ample body of scientific literature that is available to describe the well-known and accepted physical impacts of terminal groins and beach fill. It then fails to accurately describe the direct, indirect, and cumulative impacts that these activities would have on biological resources within Shallotte Inlet, particularly the Piping Plover and Red Knots. Instead, adverse impacts to Piping Plovers, Red Knots, other bird species, and their prey (infauna) are largely dismissed or ignored. The best, most recent data and peer-reviewed literature available to assess those impacts are omitted or misrepresented, and the recommendations of multiple management and recovery plans, including USFWS recovery plans, are largely disregarded.

Response: The Biological Assessment includes recent data and peer-reviewed scientific literature. During consultation with the USFWS, a review of the scientific literature and an analysis of the potential impacts to bird species and their habitats was conducted. The proposed project may affect and is likely to adversely affect the piping plover, red knot. The applicant will be required to comply with all terms and conditions of the USFWS' BO dated August 6, 2015. All terms and conditions of the BO will be incorporated as special conditions of any Corps authorization. The USFWS BO also includes measures to minimize impacts to migratory shorebirds in the project area.

E.17. Comment: Alternatives 3, 4, and 5 as presented in the FEIS would jeopardize the recovery and/or persistence of the Great Lakes breeding population of Piping Plover, the Atlantic coast breeding population of Piping Plover, Seabeach Amaranth, and Red Knot; and a terminal groin would permanently eliminate habitats for these species listed under the Endangered Species Act without any chance of restoration or reformation in other areas. The alternatives in the FEIS that involve hard structures, channelization (Alternatives 5 and 4) or nourishment on a two-year cycle (Alternative 3) at Shallotte Inlet should be permanently removed from further consideration and other alternatives should be considered.

Response: The conclusion of the USFWS Biological Opinion asserts that the proposed project, under Alternative 5, would not jeopardize the continued existence of any federally listed species, nor result in the adverse modification of any designated critical habitat.

Comments from the National Marine Fisheries Service (HCD) in a letter dated May 31, 2016:

F.1. Comment: Based on the information provided, the NMFS has no EFH conservation recommendations for the project. The NMFS may provide EFH conservation recommendations in the future based on new information or changes in the project design that show adverse impacts would occur to EFH or federally-managed fishery species.

Response: Comment noted.

Comments from the US Fish and Wildlife Service in a letter dated May 20, 2016:

G.1. Comment: The Service continues to recommend that the proposed project not be authorized. The proposed project has the potential to adversely affect nesting female sea turtles, nests, and hatchlings on the beach, piping plovers, red knots, and seabeach amaranth within the proposed project area.

Response: Comment noted. These potential effects were evaluated in the USFWS BO. The USFWS agreed that the project is not likely to adversely affect the West Indian manatee and the hawksbill sea turtle. The proposed project may affect and is likely to adversely affect the piping plover, red knot, seabeach amaranth, and the loggerhead, leatherback Kemp’s Ridley, and green sea turtles. The applicant will be required to comply with all terms and conditions of the USFWS’ BO dated August 6, 2015. All terms and conditions of the BO will be incorporated as special conditions of any Corps authorization. The USFWS’ BO also includes measures to minimize impacts to migratory shorebirds in the project area. The terms and conditions of the BO would mitigate adverse effects to threatened and endangered species and shorebirds.

NMFS concurred that the project is not likely to adversely affect threatened and endangered sea turtles.

G.2. Comment: Potential effects to sea turtles include disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of lighting or presence of the groin, and behavior modification of nesting females during the nesting season resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs due to escarpment formation or presence of the groin within the action area. The presence of the groin could affect the movement of sand by altering the natural coastal processes and could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest and crawl to the ocean. The presence of the groin may create a physical obstacle to nesting sea turtles, and the proposed groin is anticipated to result in decreased nesting and loss of nests that do get laid within the project area for all subsequent nesting seasons following the completion of the proposed project.

Response: These potential effects were evaluated in the USFWS BO. The applicant will be required to comply with all terms and conditions of the USFWS’ BO dated August 6, 2015. All terms and conditions of the BO will be incorporated as special conditions of any Corps authorization. The terms and conditions of the BO would mitigate adverse effects to threatened and endangered species.

NMFS concurred that the project is not likely to adversely affect threatened and endangered sea turtles.

G.3. Comment: Potential effects to piping plover and red knots include degradation and loss of habitat, particularly down-drift of the structure. Groins can act as barriers to longshore sand transport and cause downdrift erosion (Hayes and Michel 2008), which prevents optimal habitat creation by limiting sediment deposition and accretion. The proposed action has the potential to adversely affect wintering and migrating red knots, wintering and migrating piping plovers and their habitat from all breeding populations, and breeding piping plovers from the Atlantic Coast breeding population that may use the project area. Potential effects to piping plover and red knot include direct loss of foraging and roosting habitat in the Action Area and in the updrift and downdrift portions of the project area, degradation of foraging habitat and destruction of the prey base from sand disposal, and attraction of predators due to food waste from the construction crew. Plovers and red knots face predation by avian and mammalian predators that are present year-round on the wintering and nesting grounds. Although the piping plover is not currently known to nest in the Action Area, the stabilization of the shoreline may also result in less suitable nesting habitat for all shorebirds, including the piping plover.

Response: These potential effects were evaluated in the USFWS BO. The applicant will be required to comply with all terms and conditions of the USFWS' BO dated August 6, 2015.

G.4. Comment: Structural development along the shoreline and manipulation of natural inlets upset the naturally dynamic coastal processes and result in loss or degradation of beach habitat (Melvin et al. 1991). As beaches narrow, the reduced habitat can directly lower the diversity and abundance of biota, especially in the upper intertidal zone. Shorebirds may be impacted both by reduced habitat area for roosting and foraging, and by declining intertidal prey resources (Defeo et al. 2009; Dugan and Hubbard 2006). Shorebird habitat has been, and may continue to be, lost where hard structures have been built (Clark in Farrell and Martin 1997). In addition to directly eliminating red knot habitat, hard structures interfere with the creation of new shorebird habitats by interrupting the natural processes of overwash and inlet formation. Where hard stabilization is installed, the eventual loss of the beach and its associated habitats is virtually assured (Rice 2009), absent beach nourishment, which may also impact piping plover and red knots. Where they are maintained, hard structures are likely to significantly increase the amount of piping plover and red knot habitat lost as sea levels continue to rise.

Response: These potential effects were evaluated in the USFWS BO. The applicant will be required to comply with all terms and conditions of the USFWS' BO dated August 6, 2015.

G.5. Comment: Potential impacts to seabeach amaranth include burying, trampling, or injuring plants as a result of construction operations and/or sediment disposal activities; burying seeds to a depth that would prevent future germination as a result of construction operations and/or sediment disposal activities; and, destruction of plants by trampling or breaking as a result of increased recreational activities. The Applicant proposes to place sand between November 15 and March 31 of any given year. However, given favorable weather, seabeach amaranth plants may persist until January. Therefore, there is still the potential for sand placement to adversely impact plants in the Action Area. Indirect impacts to seabeach amaranth include degradation of habitat from stabilization of the shoreline.

Response: These potential effects were evaluated in the USFWS BO. The applicant will be required to comply with all terms and conditions of the USFWS' BO dated

August 6, 2015. All terms and conditions of the BO will be incorporated as special conditions of any Corps authorization. The terms and conditions of the BO would mitigate adverse effects to threatened and endangered species including Seabeach Amaranth.

G.6. Comment: Responses to Comments 106, 107, and 108 (Appendix G, Pages 11 and 12) do not adequately address the Service's concerns for potential down-drift erosion within Shallotte Inlet.

Response: The design of the structure is such that it is a leaky structure that will allow for sediment transport towards the inlet, thereby minimizing the effects to downdrift dry beach front. Water circulation along the up-drift side of the structure would be altered during the construction and immediately upon completion of the structure. However, long term alteration of currents and circulation would be minimized by the groin design and the construction of the fillet behind the structure. In the event that the terminal groin adversely affects the nearby shorelines, the applicant will be required to alter the height and/or the configuration of the terminal groin or remove the terminal groin in order to mitigate for the adverse effects (as required by NC Senate Bill 110). The rubblemound portion of the terminal groin would be constructed with loosely placed armor stone on top of a foundation mat or mattress and would have a crest elevation of +4.9 feet NAVD. The loose nature of the armor stone was designed to facilitate the movement of littoral material through the structure while the relative low crest elevation of +4.9 feet NAVD would allow some sediment to pass over the structure during periods of high tide.

G.7. Comment: Responses to Comments 109, 110, and 115 do not adequately address the Service's concerns with the estimation of costs of the five alternatives. The FEIS discusses 45 dwellings and 155 total parcels east of station 15+00 which are threatened by erosion over the next 30 years. The Draft EIS listed 238 total parcels, but concerns expressed by our agency and others led to revision of the total lot number. However, the location of the 155 parcels is still not clearly demarcated on any figures, nor are their locations adequately described in the text. There is no discussion in the FEIS about why these empty parcels are threatened by erosion over the next 30 years, and so the level of threat to those parcels is not clear. Figure 3.1 on page 27, which shows future scarp line positions under Alternative 1 does not appear to be revised since the DEIS and does not show 155 parcels within the erosive area. As stated in our comments to the DEIS, there are approximately 80-90 parcels shown on this figure. Please clearly explain where the other 65-75 parcels are located with respect to the proposed project, and why they are threatened by erosion over the next 30 years.

Response: The number of parcels potentially impacted by the continued movement of the scarp is correct. The parcels removed from the Draft EIS were parcels with tax values less than $2000 hence the relatively small difference in the potential damages between the DEIS and the FEIS. Parcels with values less than $2,000 are non-conforming (i.e., cannot meet existing NC DCM setback requirements) and are not included in the analysis. The houses on the east end of Ocean Isle Beach that were lost in the past were all located south of E 2nd Street. The density of development south of E 2nd Street was considerably less than the density of development that currently exists on the east end of the island that is threatened by continued retreat of the scarp line. Given the higher density of development, future loss of homes would be expected to be greater. Additional information regarding the number of parcels susceptible to erosion has been provided in Appendix D of this document.

G.8. Comment: On Page i of the Executive Summary, and pages 155 and 160, the text still refers to 23 parcels that are vulnerable to erosion.

Response: Error noted. The correct parcel number as amended in the body of the FEIS was used in analysis.

G.9. Comment: The predicted loss or protection of the 155 parcels factors heavily in the estimated costs of each alternative. For example, on pages 27 and 28, in the discussion of the 30-year cost of Alternative 1 (No Additional Action) and Alternative 2 (Abandon/Retreat), the loss of the 155 parcels is estimated to cost $21.36 million. This is only $30,000 less than the cost when 238 parcels were considered to be threatened. The Service recommends that the precise area that the FEIS claims will be impacted by Alternative 1 and protected from long-term erosion by Alternative 5 should be clearly demarcated on a figure, including clear demarcation of all 155 parcels. If a figure cannot be provided, then a list of all 155 parcels (including street addresses) and their current tax values should be provided in the Appendix.

Response: Figure 3.1 depicts the future scarp line and parcels threatened by the movement of the line projected over 30 years. The 155 parcels are derived from tax information from Brunswick County GIS and are those parcels that have a tax value of $2,000 or greater. Additional information regarding the number of parcels susceptible to erosion has been provided in Appendix D of this document.

G.10. Comment: Table 5.5 on Page 82 of the Engineering Report indicates that over 30 years, the costs for the non-federal share of the five alternatives are so similar that the differences appear to be insignificant. In fact, the costs for Alternative 1 (No New Action) and Alternative 2 (Abandon/Retreat) are only $420,000 more than the preferred alternative, a difference of less than 2%. We recognize that the federal share (and the total cost) is higher for Alternatives 1 and 2 than for Alternative 5.

Response: Comment noted. The cost analyses used for this document include those presented in Chapter 3 of the FEIS as well as from the engineering report.

G.11. Comment: As for the remainder of our comments, the Service believes that our mostly editorial comments were adequately addressed in the FEIS. The Service's comments and concerns about impacts to our trust resources, downdrift erosion, and the inability to model past three years for a 30-year project were not. However, it is unlikely that the applicant could address these comments adequately without significantly revising the project or changing their preferred alternative, and as far as we can tell, there have not been any significant revisions to the preferred project.

Response: These potential effects to USFWS trust resources were evaluated in the USFWS BO and included in the USACE evaluation of the project. Model simulations for all the alternatives were carried out over a three-year period. The use of the three-year period was based on the periodic nourishment interval for the federal storm damage reduction project. The formulation of each of the alternatives, particularly the alternatives involving beach nourishment, was based on the modeled performance of the beach fill over the three-year model simulation. In some instances, the modeled performance of the beach fill as well as criteria established to evaluate the alternatives suggested periodic nourishment intervals either shorter or longer than three years. However, since the model results were only used to obtain a relative comparison of the performance of each alternative, the three-year model simulation provided sufficient information on which to make engineering judgements with regard to determining long-term periodic nourishment requirements of each of the alternatives. Finally, the potential for downdrift erosion and required mitigation measures were evaluated in the FEIS and in this document.

<u>Comments from the North Carolina Coastal Federation in a letter dated May 31, 2016:</u>

H.1. Comment: The Corps must submit a supplemental EIS, in which it fairly evaluates all alternatives for addressing the problem of erosion at OIB. Furthermore, the Corps must resolve the comments and concerns expressed in the DEIS that were not adequately addressed in the FEIS.

Response: Additional modeling for Alternative 4 has been performed and it is our determination that each alternative was appropriately evaluated in accordance with NEPA and other laws and regulations governing the Corps Regulatory Program.

H.2. Comment: The Corps does not explore the alternatives equally...The Corps responds to this criticism by stating that it added a model specific to Alternative 4 in the FEIS in order to establish objectivity over all of the alternatives. However, this response makes the assumption that the lack of a model for Alternative 4 is the only instance in which substantial equal treatment was lacking. In reality, there are numerous other places within the report where equal consideration is not given, clearly demonstrating that there is a bias towards the preferred alternative of the terminal groin.

Response: It is our determination that each alternative was appropriately evaluated in accordance with NEPA and other laws and regulations governing the Corps Regulatory Program. Without being provided specific examples, the statement "numerous other places in the report where equal consideration is not given" cannot be evaluated and addressed.

H.3. Comment: ...favoritism was plainly expressed in the DEIS when the Corps described its purpose as to "refine the terminal groin's design and develop a recommended plan which includes groin construction and strategic placement of beach fill." In a comment letter sent in reaction to the DEIS, the federation specifically mentioned this sentence. Responding in the FEIS, the Corps alters the original statement, replacing it with the phrase, "The objective of the Engineering Report (Appendix B) is to disclose the methodology involved with developing all project alternatives." However, changing the wording of one line does little to improve the overall character of the document. Rather than merely adjusting the stated purpose, the Corps needs to rework the entire document so that it gives objective and equal consideration to all alternatives

Response: It is our determination that each alternative was appropriately evaluated in accordance with NEPA and other laws and regulations governing the Corps Regulatory Program.

H.4. Comment: Analysis in the FEIS indicates that Alternative 4 rivals Alternative 5 in its effectiveness as the Corps states that Alternative 4 would result in "the buildup of material on the west side of Shallotte Inlet," protecting the eastern end of Ocean Isle and "resulting in accretion along the entire sand spit." Thus, it is unclear why Alternatives 4 and 5 are not more closely compared and why Alternative 5 is overwhelmingly favored.

Response: The same methodology was utilized to evaluate all alternatives. Alternative 4 was evaluated in the numerical model by simulating re-dredging of the Shallotte Inlet Borrow Area/Channel using modeled conditions at the end of Year 3 under Alternative 1 as a starting point. The model was then run for an additional 3 years to see if maintaining the borrow area/channel in a fixed location and alignment would produce accretion along the east end of Ocean Isle Beach. The results obtained by the model indicated volumetric losses off the east end of Ocean Isle Beach would be reduced during the 3 years following the second channel dredging operation. However, as described in Appendix B of the FEIS results from modeling scenarios and through analysis conducted in the 1997 General Revaluation Report compiled for the CSDRP, the buildup of material on the west side of Shallotte Inlet from channel alignment was shown to be temporary due to the high erosion rate on the extreme east end of Ocean Isle Beach and the formation of the ebb tide delta proved too close to the inlet to provide significant protection to development on the east end of Ocean Isle Beach (pg. 48 Appendix B of FEIS). Therefore, in regards to the purpose and need of maintaining shore protection on the east end of the island, Alternative 4 does not perform as well as Alternative 5. Also, even though volume losses off the east end of Ocean Isle Beach could be reduced through repetitive dredging of the borrow area in the same location, the cost of Alternative 4 over the 30-year evaluation period exceeded the 30-year cost of Alternative 5 by about 16%. Furthermore, Alternative 4 would result in long term, irreversible impacts to the aquatic environment through more frequent dredging and disposal and permanent realignment of the inlet throat.

H.5. Comment: After the publication of the DEIS, there were concerns that the modeling tool was not only poorly suited to modeling processes as dynamic as sediment transport and shoreline erosion, but also that the parameters and assumptions in the model set-up were not representative of the area (as is evidenced by historical inaccuracies in previous modeling attempts of OIB and Holden Beach). Additionally in the DEIS, the Corps did not include in-depth models of every scenario, but rather initially and possibly intentionally excluded modeling of two of the alternatives (Alternatives 2 and 4). The Corps has not adequately addressed these concerns in the FEIS. While slight modifications have been made to include further analysis on the previously disregarded alternatives, a bias favoring the pre-determined preferred alternative very evidently still remains in the analysis

Response: The numerical model used in the evaluation of the alternatives was run using the same set of initial bathymetric conditions and forcing functions (tides, waves, winds, etc.) for all the alternatives. Therefore, differences in the response of the model to the various alternatives was due solely to changes in sediment transport patterns associated with the simulated man-induced changes such as a new channel or structure. With the only difference between Alternative 1 and Alternative 2 being the use of sandbags under Alternative 2 to protect properties on the east end of Ocean Isle Beach, the model results obtained for Alternative 1 are directly applicable to Alternative 2.

Following the comments received on the DEIS, the numerical model was run for Alternative 4 as well as the other alternatives, in order to obtain a direct comparison of the relative difference in the model's response to each alternative. These additional runs of the model were independently verified by the USACE Wilmington District Engineering Branch and comments from the review were incorporated into alternatives analysis. The results of the new round of model simulations are provided in Appendix B of the FEIS and used in the issuance of this ROD.

H.6. Comment: The method behind the choice of the final [Delft 3D model] calibration still remains unclear. The relative differences between the observed volume changes (actual past shoreline positions) and those shown by the calibration run among the three runs are minimal. Furthermore, the numerical differences in calibrated versus observed volume changes among the three runs close to the inlets are negligible – spanning from none or only a few c.y./foot (i.e. OI_045 and OI_040 in #43A and #43B are the same) to about 10 c.y./foot (i.e. OI_025 in #43A and #43B; and HB__390, HB_385 and HB_380 in #43 and #43A) per transect. Thus, the selected calibration run differs minimally from the two rejected. Overall, all three calibration runs fail to replicate the observed shoreline positions.

Response: While there were subtle differences in the various calibration runs, Run #43A was used to indicate the relative significance of the modeled differences in the response of Shallotte Inlet and the adjacent shorelines to man-made changes and interpret whether or not significant negative or positive impacts on the affected shorelines would be expected.

H.7. Comment: The Delft3D calibration run fails to replicate past observed shoreline positions...As expressed in the federation's DEIS comments, the calibration run was unable to replicate the observed shoreline changes. For example, calibration #43A shows erosion between stations HB340 and HB300, whereas the island actually experienced accretion. The Corps responds, in the FEIS, that the relevant factor in the calibration is not the agreement of the model with the observed change but the trends on both sides of the inlet as obtained in calibration run #43A. These trends are certainly not observed at station HB400, where the calibration shows erosion while the observed trend was accretion. The Corps' arguments in response to concerns are unsupported. To address this inadequacy, the Corps needs to provide a reasonable and supported argument for choosing one calibration run over others and for determining that the chosen calibration run adequately simulates future shoreline changes.

Response: While none of the model runs was completely predictive, the shoreline response produced by calibration run #43A followed the same general trends on both west end of Holden Beach and the east end of Ocean Isle Beach. Since all model simulations used the same input parameters to force the model (i.e., same waves, tides, & winds) and all alternatives were initiated using the same bathymetry (except for changes due to the various alternatives) the response of the model to each alternative was due solely to the changes in sediment transport patterns that would be caused by the respective alternative.

H.8. Comment: The Corps claims that in calibrating and simulating shorelines with Delft3D, achieving a correct shoreline trend outweighs achieving actual replication of the observed shoreline change. This claim proves that the model's numerical results of sand volume changes obtained by the model simulation should not be taken into consideration. However, the Corps relies on these numerical results of simulated sand volume change throughout the document, particularly when comparing the five alternatives."

Response: The numerical model is not a tool to predict the future. The model, rather, provides an output that is based solely on the input data (regarding wind, waves, tides, etc.). The model then allows the user to compare the relative changes between alternatives that were run based on the same input.

The model results were used in relative terms to determine if an alternative would be expected to induce more or less volume change along various shoreline segments east and west of Shallotte Inlet. The relative comparisons were also used to interpret potential changes to Shallotte Inlet associated with each alternative. The relative results obtained by the model were converted to "real-world" values based on measured changes along the shorelines and in the inlet obtained from monitoring surveys.

H.9. Comment: The Corps is contradictory in its statements: the Corps says the FEIS only relies on simulating the shoreline trend rather than the actual numerical data when referring to modeling simulation; yet, the Corps relies on the exact simulated numerical volume change results when comparing alternatives, with the goal of choosing the preferred terminal groin and assessing the economic costs. The Corps needs to make a decision as to whether the modeling tool is relied upon to approximate general trends or to calculate sand volume changes, and apply that decision consistently. In the current FEIS, the Corps flip-flops between both sides, further illustrating the misuse and manipulation of the model results.

Response: As previously stated, the model results were used to determine relative differences in the response of the model to the different man-induced changes associated with each alternative. If for example one alternative indicated a section of Ocean Isle Beach would experience a 25% increase in volume loss compared to Alternative 1, the model indicated volume loss for that alternative would be converted to an actual volume loss by multiplying this percent change times the measured volume changes obtained from the monitoring surveys.

H.10. Comment: The federation and Southern Environmental Law Center (SELC) expressed concerns about the three-year timeline used for the modeling simulation. In response, the Corps states that running the model for an extended period of time using the same input parameters, while possible, would not be relevant." However, in addressing the lack of modeling simulation for Alternative 4, the FEIS ran the simulation for nine years, showing graphic results of only years four through six post groin, but including numerical results for all nine years. This change in the modeling timeline renders the Alternative 4 incomparable to other alternatives thus preventing the objective comparison of all alternatives. The Corps needs to issue a Supplemental EIS with modeling results for at least nine years for all alternatives and compare volume changes and costs of all alternatives in one easily understandable table. In addition, the Corps needs to provide tables that compare periodic nourishment needs and sand volume changes, expressed in the same units of time. Furthermore, an updated analysis needs to include clearly defined contours (i.e. -6 ft NAVD or -18 ft NAVD) for each alternative being compared.

Response: Simulation of Alternative 4 was run for a period of 3 years following the simulated "re-dredging" of the inlet channel to assess whether or not keeping the channel in a fixed location and alignment would result in positive changes on the east end of Ocean Isle Beach. The first 3-years of the simulation for Alternative 4 were identical to Alternative 3 in that both alternatives involved dredging of the Shallotte Inlet Borrow Area and placement of a beach fill along the east end of Ocean Isle Beach. However, Alternative 4 simply used the model results obtained under Alternative 3 at the end of Year 3 of the simulation as a starting point for re-dredging the borrow area. The relative reduction in volume loss along the east end of Ocean Isle Beach obtained for Alternative 4 during simulated model years 4, 5, and 6 were then assumed to be applicable over an ensuing 3-year period if the borrow area/channel was again re-dredged in the exact same footprint. Thus, while projections in volume loss from the east end of Ocean Isle Beach under Alternative 4 were extended to 9 years, the actual model simulation applicable to Alternative 4 only replicated 3 years.

Periodic nourishment requirements are provided in the FEIS and give the volumes and frequency of nourishment under each alternative.

H.11. Comment: The Corps needs to (1) provide reasoning for how the relative differences in the model make it a valid way of analyzing alternatives and (2) re-do the analysis to forecast much further than three years into the future.

Response: The three-year simulations for the alternatives are adequate to develop relative differences in the response of the Shallotte Inlet/beach system to man-induced changes associated with the alternatives. The existing behavior of the shorelines on each side of Shallotte Inlet have been documented with monitoring surveys. By using the results of Alternative 1 to represent the behavior of the shorelines and inlet under existing conditions, comparing the model results for the other alternatives to Alternative 1 provides a basis for determining the relative differences in expected shoreline impacts and a means to extrapolate the model results to actual volume changes that would be expected to occur.

H.12. Comment: A comparison of the DEIS and FEIS indicates that many inconsistencies remain between the economic analysis and the modeling for each alternative. This is especially true when applying the results of a three-year model to conduct a 30- year cost analysis. The federation and the SELC raised concerns regarding the discrepancy between these timescales. The Corps defends the model by stating that it “is not used to ‘predict’ future changes since predictions of climatic conditions far into the future are not possible.” However, this response does not adequately answer the concerns raised...The Corps needs to execute an economic analysis that does not rely on an unreliable model with a much shorter timescale.

Response: Typically, the economic impact of one alternative versus another is based on projections of what may occur in the future. In some instances, these projections are based on changes observed in the past and then simply projected to continue to occur in the future. This is the approach taken for Alternatives 1 and 2. Therefore, the numerical model was not used to determine potential future damages under Alternatives 1 and 2. For all the alternatives that involved a beach fill and/or terminal groin, damages due to a continuation of long-term erosion that was applicable to Alternatives 1 and 2 were assumed to be prevented by implementation of either Alternatives 3, 4, or 5. In these instances, the model results were used to estimate relative differences in the amount of periodic nourishment that would be needed under each alternative to prevent long-term erosion damages.

H.13. Comment: In response to the federation's concern regarding the parcels used in the DEIS, the Corps amends the number of parcels included in its analysis in the FEIS to be parcels of land valued at $2,000 or above. This decreased the total number of parcels from 238 (as assessed in the DEIS) to 155 (as newly assessed in the FEIS). However, the location of these parcels is still unclear.

Response: Additional information regarding the number of parcels susceptible to erosion has been provided in Appendix D of this document.

H.14. Comment: The Corps fails to explicitly state in its responses to comments whether the parcels used in the analysis and model simulations include submerged lots. Instead, the Corps reports in the FEIS that it has modified the parcel estimate in accordance with the Brunswick County GIS, which shows no developable parcels to the east of station 0+00, as further evidence of addressing concerns over parcels estimates. The Corps needs to provide a list of addresses for the 155 parcels (including the 45 structures) used in the assessment in order to provide transparency in its analysis and support cost assessments attributed to parcel damages.

Response: Additional information regarding the number of parcels susceptible to erosion has been provided in Appendix D of this document. This information identifies each of the parcels included in the analysis by its PIN number and Parcel ID as well as identifies the owner(s).

H.15. Comment: There is a disproportionate level of detail in the cost analyses of each of the alternatives. Costs of Alternatives 1 and 2 are overestimated, because the Corps adds the costs that would be shared by the federal government (in regards to renourishment) to the overall cost for these alternatives. In the FEIS, the Corps maintains this action, explaining that "other alternatives could increase periodic nourishment costs while others would actually reduce nourishment costs". However, including these costs shared by the federal government is inconsistent and shows a skewed perception of costs that would impact the Town of Ocean Isle Beach. These additional costs inflate the actual costs of Alternative 1 and 2 by 43.19 million dollars. Moreover, it is unclear in Alternative 3 whether or not the federal share of the costs is included.

Response: One of the objectives of the project on the east end of Ocean Isle Beach is to reduce the cost of maintaining the federal storm damage reduction project. Therefore, the total cost for nourishing the federal project, including both federal and non-federal costs, is included in the evaluation of the cost of all the alternatives. In some instances, an alternative may affect both the federal and non-federal costs while in other instances; only the non-federal costs are impacted. In order to provide an equitable comparison, all of the economic costs associated with each alternative are presented.

H.16. Comment: …the FEIS includes not only costs attributed to the town of Ocean Isle, but also costs that would be borne by private stakeholders - specifically parcel owners and developers. The costs for Alternatives 1 and 2 not only include damages and related repairs to roads and utilities, but also costs associated with relocating, demolishing or repairing affected structures (such as beach homes). Such costs would be borne by property owners and not by the town. The Corps defends this action by explaining that each alternative was equally evaluated in every aspect in accordance with federal storm damage reduction projects. Yet, Alternatives 3, 4, and 5 are modeled to show no damage due to erosion. Therefore, the costs attributed to Alternatives 1 and 2 are overestimated in comparison to Alternatives 3, 4, and 5, which only include costs that the Town of Ocean Isle would be responsible for. The lack of consistency over cost distribution renders cost comparisons across alternatives invalid and questionable.

Response: Alternatives 3, 4, and 5 have the same potential to eliminate damages due to a continuation of long-term erosion; therefore, damages due to long-term erosion would be eliminated under all three of these alternatives. Economic comparisons included in the FEIS appropriately include all economic impacts whether they be to the public or private sector. Action taken by the private sector to respond to erosion damages would utilize the same mechanisms that the public sector would use to respond to the damage.

H.17. Comment: In the FEIS, the Corps estimates the groin's annual structural maintenance to be $13,000/yr for a 500ft terminal groin. This differs significantly from the price estimate developed in the 2010 Coastal Resources Commission's (CRC) terminal groin study, which provides some base cost estimates for terminal groins. This study approximated the annual structural maintenance for a 450ft groin, not including associated costs such as beach nourishment, to be around $125,000/year. The large disparity between the two estimates is concerning as it indicates that the gross underestimation of annual costs for terminal groin maintenance has led to incorrect assumptions of the fiscal viability of this alternative. The Corps needs to correct the maintenance cost for the preferred alternative in its analysis.

Response: The applicant stated that the 2010 CRC terminal groin study overestimated the annual maintenance cost. The maintenance cost for the Ocean Isle Beach terminal groin was based on having to replace an average of 1% of the armor stone every year over the 30-year project life. The maintenance costs included in the State's study were estimates based on maintenance costs for a few older structures in the State of Florida. The report noted there have been minimal to no maintenance required for the two terminal groins in North Carolina.

H.18. Comment: In response to the comments that outlined the DEIS' failure to follow scoping requirements of NEPA, the Corps merely replies that the requirements were "satisfied". The response does not address the concern that the single scoping meeting held by the Corps did not satisfy the requisite scoping that should have occurred throughout the planning and early stages of EIS preparation. 43 CFR § 46.235 refers to the scoping process as to be conducted through “meetings”, plural, as well as through “newsletters and other communication methods appropriate to scoping."

Response: A Project Review Team (PRT) was assembled and included various entities including state and federal regulatory and resource agencies, non-profit environmental organizations, the applicant and their agents. The PRT approach allowed viewpoints from all perspectives to be addressed and to help prepare a non-biased, all-inclusive EIS disclosure document. This team formally met on October 3, 2012, and March 5, 2013. A description of all meetings and a list of team members can be found in Appendix A (Scoping) of the FEIS. An official public scoping meeting was held on March 5, 2015 and a public hearing was held on March 3, 2015.

Through the NEPA review, all alternatives were subject to agency and public review and input. Our NEPA review included a public scoping meeting, public hearing on March 3, 2015, PRT meetings and the circulation of public notices on the Draft and Final EIS.

H.19. Comment: The federation also noted that the Corps did not employ plain language and readily understandable and appropriate graphics in the EIS. The Corps does not improve upon this in the updated EIS. Like the DEIS, the FEIS fails to standardize its references to the project area, and instead uses numerous different combinations of street names, distances, and station numbers as reference. Additionally, the FEIS alternates between the words “structure”, “building”, and “dwelling” when discussing construction on the parcels, never clearly defining what these are and whether they differ from each other. Recommendations that the structure and organization of the DEIS be simplified went unheeded and no changes were made in the FEIS. The labyrinth-like arrangement of the FEIS requires large amounts of bouncing back and forth between the main body of the FEIS document and its appendices. Therefore, the FEIS continues to be in noncompliance with 40 CFR §1502.8. The Corps must reorganize and simplify the document so that the NEPA purposes of transparency and true public involvement are satisfied.

Response: The FEIS was drafted and coordinated in accordance with 40 CFR §1502.8.

H.20. Comment: The FEIS does not address the full range of impacts that this project will have on the environment -- direct, indirect, and cumulative. It uses Alternative 1 as the unequivocal standard of all that will come to be if a different approach is not employed. However, as is mentioned above, the Delft3D modeling system used for

Alternative 1 in the FEIS is unreliable. Using the model to make a whole host of other assumptions is not good science and does not result in an accurate analysis.

Response: Each factor, environmental or otherwise, addresses the direct, indirect, and cumulative impact for each alternative. The Delft3D model is the best tool available at this time. The Corps also relied on information provided by scientific experts in multiple disciplines at the USFWS, the NMFS, NCDCM, NCDMF, and the NCWRC. Therefore, the Corps has determined that the best available science has been utilized for the project review.

H.21. Comment: The federation made this point that the DEIS analysis did not encompass all of the potential environmental impacts of the terminal groin. In its response, the FEIS states that numerical models were the only way to evaluate the potential impacts, as these geographic areas are extremely dynamic and ever-changing. The Corps needs to submit evidence supporting its conclusions on the potential environmental effects of the terminal groin.

Response: The shoreline change is the fundamental driver to potential environmental impacts (to habitat and species) that could result from the proposed project. Delft3D model is the best available tool to measure the potential change to the shoreline relative to each alternative and, therefore, it can be used to determine potential environmental effects of the terminal groin and each other alternative. In addition to potential changes to the shoreline from modeling, the Corps considered other sources, such as review of relevant literature, coordination with resource agencies, Biological Assessments, Essential Fish Habitat Assessments, and past dredging and nourishment projects in the area to determine the environmental effects of the proposed alternatives.

H.22. Comment: The federation stands by its previous conclusion that Alternative 4 for the Realignment of Shallotte Inlet Ocean Bar Channel (including federal project) is the preferred and best alternative for addressing the issue of erosion on the East end of Ocean Isle Beach. The flawed and highly subjective analysis in the FEIS does not do this option justice, but instead slants the analysis -- both quantitative and qualitative - in favor of the terminal groin. Therefore, it is critical that the Corps conduct further analysis and submit a Supplemental EIS that objectively finds a method for mitigating erosion on Ocean Isle Beach. Until then, no further action should be made in the decision-making and approval process.

Response: The FEIS is clear in demonstrating that Alternative 4 will result in increased environmental impacts and increased cost compared to Alternative 5. Environmental impacts would be higher for Alternative 4 due to reoccurring inlet channel relocation maintenance and the increased nourishment interval (approximately every 4 years) opposed to approximately every 5 years as anticipated under Alternative 5. Over the 30-year planning period, the total cost for Alternative 4 was estimated to be $53.15 million and $45.86 million for Alternative 5.

Comments from the Southern Environmental Law Center in a letter dated May 31, 2016:

I.1. Comment: NEPA requires the Corps to "independently evaluate the information submitted" by an applicant seeking the preparation of an EIS, and the Corps is "responsible for its accuracy." 40 C.F.R. § 1506.5(a). Adopting an applicants' analysis wholesale, without independently reviewing aspects such as the statement of purpose and need and the range of alternatives, and without exercising independent judgment, violates NEPA. As a basic NEPA requirement, when an agency does choose to "use the information submitted by the Applicant in the environmental impact statement, either directly or by reference, then the names of the persons responsible for the independent evaluation shall be included in the list of preparers." 40 C.F.R. 1506.5(a). The FEIS, which fails even to include a list of preparers—let alone identify any individual Responsible for the independent evaluation—violates not only this provision, but also the more general requirements of 40 C.F.R. § 1502.17.

Response: A list of preparers is available in Appendix B of this document.

I.2. Comment: Even had the Corps identified that it had independently verified CPE's analysis and exercised its own expertise, deference accorded an agency's scientific or technical expertise is not unlimited. Specifically, an agency's analysis must have a "rational basis", be "consistently applied", and take "relevant considerations into account". Here the FEIS falls down at every step. The FEIS admits that the methodology used has no "rational basis." In fact, the FEIS makes clear over and over again that the underlying Delft3D model used to forecast future impacts was "not intended to represent predictions of what changes to expect in the future." Likewise, far from being "consistently applied," entirely different erosion rates and methodologies were used to calculate the economic and environmental impacts of the project and "relevant considerations," such as the fact that recent trends on the beach have been the exact opposite of those predicted by the model used in the EIS, have not been taken "into account," but rather ignored entirely.

Response: This is a two-part comment dealing with the use of the Delft3D model to determine relative differences in response of the system to man-induced changes and erosion rates used in the EIS.

Part 1-Relative Differences: Response to using the Delf3D to determine relative difference follows with an explanation of the erosion rates provided below. In applying the Delft3D model to determine relative differences in the response to different engineering alternatives, the model is first run to represent the No Action Alternative in which there are no new man-made changes to the system. For the analysis of the engineering alternatives, the model is run with the same forcing functions as the No Action Alternative; therefore any difference in the response of the system indicated by the model would be totally due to man-made changes such as the addition of a new channel, beach fill, or terminal groin. Therefore, if the model simulation for a channel alternative indicates changes in the volume of material on a section of the shoreline compared to the No Action Alternative, the differences in the response of the model was caused by the inclusion of the new channel. Since prediction of weather conditions well into the future is beyond the capability of existing science, the Delft3D model cannot "predict" future changes.

Part 2 - Erosion Rates: The justification for using the LiDAR data to evaluate movements of the erosion scarp on the east end of Ocean Isle Beach to determine future erosion impacts rather than tracking changes in the MHW shoreline is provided in Section 3.1 of Appendix B of the FEIS. In this regard, the periodic disposal of navigation maintenance material along the east end of the beach combined with eastward spreading of beach fill material from the federal storm damage reduction project distorts the movement of the MHW shoreline. In addition, the sandbag revetments installed along most of this shoreline prevents changes in the MHW position from accurately representing the real erosion threat to upland development. Therefore, changes in the location of the erosion scarp over time were used to represent the erosion threat to upland development. On the other hand, the Delft3D model was not used to determine changes in shoreline position, rather the model was used to determine volumetric changes landward of the -6-foot NAVD88 contour.

I.3. Comment: If the Corps intends to continue to move forward with permitting this project, it cannot stand on the illegal, arbitrary, and capricious analysis performed by CPE. Rather, the Corps must prepare a Supplemental EIS in which it independently verifies CPE's analysis, and then conduct additional analysis to fully, accurately, and consistently analyze a reasonable range of alternatives and their environmental impacts.

Response: The Corps managed the 3rd party contractor (CPE) in full accordance with applicable policy and regulations and has conducted an independent review of all information provided by the contractor.

I.4. Comment: The FEIS attempts to explain away the fact that this key model does not work by noting that while the model results did not agree with observed changes, those realities do not matter because the sole purpose of Delft3D is to predict "relative" changes between various alternatives. The FEIS does not explain why it is appropriate to use the model in this way. No reasoning is given as to why, if the model does come anywhere close to accurately predicting the future, it nonetheless can be trusted to accurately model proportional differences between future outcomes for different alternatives. Rather, the FEIS simply states that "an assumption was made, based on engineering judgment, that corresponding changes in the 'real world' would be proportionally the same as indicated by the model." The FEIS fails to back up this fundamental and counterintuitive assumption with any explanation as to why it is nonetheless reasonable. When an agency's analysis relies on a key assumption such as this one, it is required to explain the assumption so that the public may fully scrutinize the analysis and its roots. Rather than explain why the assumption about proportionality is legitimate and allow such scrutiny, the only citation given in support of the validity of this assumption is to a "personal communication" from Beck, T., the Chief of Coastal Engineering at the Corps, in 2014. No transcript or copy of this "personal communication" is included in the FEIS, yet it is cited for the fundamental proposition that the model—that all admit cannot predict future changes, and which has failed even to replicate past changes when all relevant factors were known—is nonetheless "valid for qualitative comparisons." The reasoning behind such a fundamental assumption of the EIS demands more explanation.

Response: As previously stated, the Delft3D model is not used to predict the future since, in order to do so, science would have to have the capability to predict weather and sea conditions well into the future. While the calibration of the model did not exactly match observed changes along Ocean Isle Beach or Holden Beach, these inherent differences would carry over to the results obtained for the various alternatives evaluated. That is, with the forcing functions being the same for all alternatives, any difference in the response of the model to the alternatives would be completely due to the changes imposed by the features of the different alternatives. Therefore, if one alternative indicated higher volume losses in one section of the shoreline compared to the other alternatives, that result would have been interpreted as being a real indication of potential negative impacts along that section of the shoreline. The relative magnitude of the impact compared to other alternatives could also be interpreted from the magnitude of the model results; however, the magnitude indicated by the model would not necessarily be directly transferrable to the real-world. For this reason, the model results were assumed to be proportional to results obtained from survey measurements. The methods used to interpret the results obtained from the Delft3D model are accepted practice within the numerical modeling profession.

I.5. Comment: In the list of "Literature Cited," the communication with Beck is noted to concern "the predictability of future changes using coastal modeling." But the broader subject of whether coastal models are predictable or not is quite a separate inquiry. Without more information, it is impossible to tell whether Beck addressed the more pertinent issue as to whether models, and specifically the Delft3D model, can reasonably be used to "pro-rate" the impacts of different project alternatives.

Response: This personal communication was made by USACE Project Manager Mickey Sugg. Tanya Beck at ERDC who has independent 1st hand experience with Delft3D agrees that the model does not provide a "prediction" of the future. Rather, it can offer results over time based on the data (wind, waves, storms, etc.) entered into the model.

I.6. Comment: ...in our previous comments we highlighted the assertion in the DEIS that the Delft3D model has "inherent accuracy" and asked that the error rate be included in the FEIS. In response to our comments the FEIS notes that "modeled elevation changes have an accuracy of (plus or minus) 0.2 feet—noting that for a 10 acre area the volume changes would have an accuracy of plus or minus 3,226 cubic yards." This "explanation" is entirely useless. Rather than present the error rate for an arbitrary 10 acres, the FEIS should have explained how accurate the model was for the area under study. Moreover, the FEIS fails to explain what this "inherent accuracy" means for a model which has been shown to be inherently inaccurate.

Response: The explanation of model accuracy is appropriate since the only reference to the accuracy of the model in the EIS was with regard to volume changes determined from the model results. The other aspects of the accuracy of the model are addressed in Appendix C of the FEIS which details the calibration and verification of the model.

I.7. Comment: The economic analysis in the FEIS continues to center on the assumption that under Alternatives 1 or 2, erosion will take place at a consistently high rate modeled on the level witnessed between 1999 and 2010. As a primary matter, this assumption is contradicted by the results of the Delft3D published elsewhere in the FEIS—further undercutting the public information process the NEPA process is intended to serve. Moreover, the use of that specific period as the rate at which erosion could be expected to "uniformly continue" for the next 30 years is entirely arbitrary. In response to our initial comments, the FEIS states that the use of this specific ten year period is appropriate to determine future erosion rates because it includes "recent man-induced changes that would have an impact on movement." This is not a rational explanation.

Response: The assumption that past erosion trends will continue into the future under the No Action Alternative is the accepted method of evaluating potential economic impacts for shore protection projects. This assumption has routinely been used to formulate essentially all USACE coastal storm damage reduction projects authorized to date. This method of establishing without project conditions is in keeping with the USACE Principals and Guidelines (ER 1105-2-100). A review of changes in the scarp position between 1993 and 2014 using Google Earth photos found the rate of scarp movement between stations 20+00 and 10+00 was actually greater than the rates used in the EIS while rates at stations 5+00 and 0+00 were only slightly less. Comparisons of the rates in the EIS (first value) and rates determined from the Google Earth photos (second value) are as follows: station 20+00; -1.1, -6.2; station 15+00; -3.2; -8.1; station 10+00; -9.2; -10.0; station 5+00; -13.0, -11.9; station 0+00; -14.3, -11.9. The history of the scarp movement on the east end of Ocean Isle Beach supports the assumption the scarp will continue to move landward under without project conditions.

I.8. Comment: First, the "man-induced changes" listed took place from between 2001 and 2010. The period used does not match this time frame —it begins in 1999. No explanation is given as to why it was appropriate to include data from 1999 but not available data from 1998 or 1997. The period between 1997 and 2010 includes the "man-induced changes" just as completely as the ten year period between 1999 and 2010, but has the added benefit of also including an example of the natural accretion that occurs at the inlet. The arbitrary decision to exclude this relevant information when projecting future erosion violates NEPA.

Response: Changes in the position of the scarp line between 1997 and 2010 are provided in Table 3.1 of Appendix B (FEIS). Over this 13-year period, the rate of scarp movement was similar to the rates used in the analysis with the annual rates slightly higher at stations 15+00 and 20+00, essentially the same at station 10+00, and slightly less at stations 5+00 and 0+00.

I.9. Comment: Moreover, the decision to place high importance on “man-induced changes” but to then ignore the equally important accretion that occurred between 1997 and 1999 requires explanation. But the FEIS includes no rationale as to why the “man-induced changes” should form part of the baseline whereas other indications of the natural cycle of erosion and accretion should not. Without directly stating as much, the FEIS appears to be asserting that natural accretion would no longer happen with “man-induced” changes in place. No explanation is given to support this assumption, however.

Response: While Table 3.1 in Appendix B of the FEIS indicates there was some accretion between 1997 and 1998 at stations 0+00 and 5+00, this brief trend reversed in 1999 with landward movement of the scarp consistent throughout the remainder of the analysis period.

I.10. Comment: The FEIS disregards entirely our reminder about the natural changes at Rich Inlet that have not only eliminated erosion at Figure Eight Island, but have resulted in substantial accretion of the northern end of the island in just a few years. To shrug off such relevant information about erosion rates at similarly-situated inlets with the mere phrase “noted” violates NEPA’s requirement to take a “hard look” and to consider and respond to public comments. Suffolk Cty. v. Sec’y of Interior, 562 F.2d 1368, 1383 (2d Cir. 1977) (“Where evidence presented to the preparing agency is ignored or otherwise inadequately dealt with, serious questions may arise about the adequacy of the authors’ efforts to compile a complete statement”); 40 C.F.R. § 1503.4(a) (requiring agencies to consider and respond to public comments on environmental impact statements).

Response: The inlet dynamics of any one inlet system vary to such a degree that comparisons that draw definite conclusions of shoreline response to erosion rates cannot be relied upon. The preponderance of quantitative evidence as presented in the EIS shows that Shallotte Inlet and subsequently the shoreline of Ocean Isle Beach is not experiencing substantial accretion in the area of concern.

I.11. Comment: Without more explanation, it appears that the Corps is cherry-picking LiDAR data that will support a quickly eroding coastline and disregarding data that demonstrates accretion as part of its bid to justify the terminal groin. This use of data to justify a predetermined outcome is exactly what NEPA prohibits. 40 C.F.R. § 1502.1, 1502.2(g).

Response: The Corps has independently reviewed the data provided by the 3rd party contractor and has concluded that accelerated erosion is indeed occurring along the eastern shoreline of Ocean Isle Beach. As described in Chapter 1 of the FEIS, twelve (12) sets of LiDAR data collected over a 16-year period between 1996 and 2012 were used for the shoreline study. These data sets had an accuracy ranging from 6.2-15cm vertical and 76-100cm horizontal. Several USACE beach profile surveys were also used for shoreline change rates and volume losses.

I.12. Comment: The DEIS used the overstated linear retreat of the scarp line to assert that 45 houses and 238 parcels would be lost over the next 30 years. We, along with several state and federal agencies, questioned this number and the FEIS was revised to state that 155 parcels would be lost. Curiously, despite the removal of 83 parcels from the analysis the overall costs associated with the loss of these properties only diminished by $30,000. Moreover, it remains unclear how the Corps is calculating this 155 parcel figure. A review of Figure 3.1 appears to show a much smaller number of parcels under threat. The 155 parcels are not clearly described either in the text or in any figure in the FEIS, thus the public is left without any ability to determine where or what the parcels are and whether they are truly under threat in the next 30 years.

Response: The number of parcels potentially impacted by the continued movement of the scarp is correct. The parcels removed from the Draft EIS were parcels with tax values less than $2000 hence the relatively small difference in the potential damages between the DEIS and the FEIS. Additional information regarding the number of parcels susceptible to erosion has been provided in Appendix D of this document.

I.13. Comment: Over the past 15 years just six houses have been lost to erosion in the project study area. For the FEIS to make the leap to conclude that erosion in the next 30 years will result in losses that are orders of magnitude greater than what has been seen to date requires significantly more support than is presented. It is essential that this information be made clear to the public and decision makers. The 155-parcel figure forms the basis for much of the economic analysis in the FEIS, and the justification for constructing the 750 foot groin. For example, the FEIS concludes that under Alternatives 1 and 2 the loss of all 155 parcels is expected to amount to $21.36 million

Response: The houses on the east end of Ocean Isle Beach that were lost in the past were all located south of E 2nd Street. The density of development south of E 2nd Street was considerably less than the density of development that currently exists on the east end of the island that is threatened by continued retreat of the scarp line. Given the higher density of development, future loss of homes would be expected to be greater. Additional information regarding the number of parcels susceptible to erosion has been provided in Appendix D of this document.

I.14. Comment: Moreover, the FEIS continues to improperly consider costs beyond those that flow to the Town of Ocean Isle Beach. As we have noted, the Town does not own the properties at issue; its only loss is future profit from tax revenue which would be a significantly lower cost. In response, comments in the FEIS state that the economic analysis "was not presented as a cost to the Town of Ocean Isle Beach per se, rather, the analysis presented the potential future loses as an overall economic impact . . . ." This analysis apparently disregards NEPA's requirement that alternatives be evaluated with reference to the stated purpose and need... The FEIS clearly states that the purpose and need for this project includes the aim "to maintain the Town's tax base by providing long-term protection of property and infrastructure . . ." The FEIS does not state that the purpose is to look generally at "overall economic impact." Not only would such a purpose be impermissibly broad, but it would require the consideration of a much expanded analysis.

Response: The FEIS contains detailed information regarding the methodology used to assess the cost of each alternative. The Corps has determined that this methodology is appropriate for economic analysis with regard to the stated purpose and need and the evaluation of the project alternatives.

I.15. Comment: The FEIS continues to err by assessing the value of lost property and infrastructure at the "replacement cost". The only loss to the Town is the potential minimal loss in tax revenue as noted above become threatened it is individual property owners, not the Town of Ocean Isle Beach, who decide whether they will abandon it or move a different location.

Response: The use of replacement cost is an accepted economic method to place a value on assets even if replacement of the asset would not be possible regardless of property owner decisions.

I.16. Comment: Similarly, the FEIS inappropriately includes the full replacement costs of infrastructure such as roads to submerged houses. These roads would not be replaced, thus the Town would incur only the cost of removing them—not the greater additional replacement cost. Replacement costs for infrastructure that will not be replaced should not be factored into the financial analysis.

Response: The use of replacement cost as a proxy to assign a value to an asset even if the asset will not be replaced is an equitable method to determine the cost of potential damages.

I.17. Comment: in calculating annual losses from the various alternatives, the EIS employs a discount rate of 4.125%. It is unclear from where this discount rate originates. There is nothing in the FEIS to support its use. The federal Office of Management and Budget currently recommends the use of a discount rate of 1.5%. The FEIS should explain why it is departing so dramatically from this discount rate.

Response: The 4.125% discount rate was applicable during the time the economic analysis was being prepared. Since that time, the USDA discount rate recommended for use in the formulation of federal water projects has steadily declined and now (2016) stands at 3.125%. The use of the lower discount rate would not materially affect the outcome of the relative economic analysis since all alternatives were evaluated using the same discount rate. Appendix E contains the documentation used for discount rates during analysis.

I.18. Comment: the analysis in the FEIS makes clear that all alternatives are "practicable." No statement is given to suggest that any one alternative could not be pursued for financial reasons, and no other barriers are noted. When determining whether an alternative is "practicable" the Corps must consider the cost to the applicant... As explained above, even when the inflated cost estimates for non-groin alternatives are included, the cost to the applicant—the Town of Ocean Isle—is essentially the same under each alternative. ..The Corps' guidance makes clear that the inquiry surrounding its duty to select the least environmentally damaging practicable alternative ("LEDPA") is "not whether an alternative 'more fully or better addresses' management plans, goals, desire, political wishes" or other "non-project purpose aspects", only the alternative with the least aquatic resource impacts may be selected, even if an alternative had greater economic or social benefits. Here, where all alternatives are practicable, the analysis must turn to which is the least environmentally damaging.

Response: The FEIS contains detailed information regarding the methodology used to assess the costs of each alternative. The Corps has determined that this methodology is appropriate for economic analysis with regard to the stated purpose and need and the evaluation of the project alternatives. See Section 9a. LEDPA determination pg. 26 of this document.

I.19. Comment: In the DEIS, [i]ndirect impacts were determined by the changes to the shoreline at Year 1 Post-Construction as interpreted from the Delft 3D modeling results…the analysis was limited to three and five years post construction. While this is a very marginal improvement over the single year of modeling indicated in the DEIS, it remains entirely inadequate. The supposed economic benefit of the project is presented over a 30-year time period and the indirect effects on a variety of natural resources will continue well beyond that time.

Response: The indirect impacts to natural resources were modeled relatively with the intent to compare the different alternatives through the same means, thereby allowing a fair comparison of each proposal. The economic data were similarly evaluated but the output of economic analysis is more applicable to 30 year future timelines than the modeling results.

I.20. Comment: the proposed project threatens to degrade habitat for birds, turtles, and fish that use inlets like Shallotte Inlet for key portions of their life cycles. There are a limited number of inlets in North Carolina and several are intensively managed, hardened, or have proposed terminal groin projects. The Corps is permitting agency for each of these inlet management projects. Yet the FEIS provides no analysis of the cumulative impact of these numerous projects on species that depend on functioning inlet systems. The wildlife that depend on the dynamic processes at Shallotte Inlet cannot simply go somewhere else—the Corps is evaluating projects to destroy those processes at the "somewhere else" as well. Yet the FEIS fails to conduct a meaningful analysis of that cumulative impact.

Response: Cumulative impact analyses are provided and discussed in Chapter 5 of the FEIS. Additionally, the cumulative effects to listed species and habitats are discussed at length in the USFWS BO and EFH Assessment. These documents were used in analysis of the alternatives and the Record of Decision.

I.21. Comment: The FEIS does not provide information required to satisfy the 404(b)(1) guidelines…The analysis of environmental impacts based on a terminal groin-oriented analysis does not provide the objective evaluation necessary to complete that analysis.

Response: The Corps has determined the environmental impacts analysis satisfies the Guidelines and provides the necessary evaluation to make a permit decision.

I.22. Comment: [W]e are concerned that the FWS's Biological Opinion does not satisfy the Corps' independent duty to insure its actions will not cause jeopardy to the species or adverse modification to critical habitat. "The ultimate burden remains on the acting agency to insure any action it pursues is not likely to jeopardize protected species" or adversely modify or destroy critical habitat. See Defenders of Wildlife v. Envtl. Prot. Agency, 882 F.2d 1294, 1300 (8th Cir. 1989) (internal quotation marks omitted). Likewise, an agency is not insulated from this responsibility merely by relying on a biological opinion; rather, "its decision to rely on [that] biological opinion must not have been arbitrary or capricious." Fla. Key Deer v. Paulison, 522 F.3d 1133, 1144 (11th Cir. 2008) (quoting Pyramid Lake Paiute Tribe of Indians v. U.S. Dep't of the Navy, 898 F.2d 1410, 1415 (9th Cir. 1990)). There are numerous flaws in the August 6, 2015 Biological Opinion which render the Corps' reliance on it fundamentally flawed.

Response: The Corps concluded consultation with the USFWS on August 6, 2015 and has satisfied all requirements of section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

I.23. Comment: At base, neither the 2015 Biological Opinion nor the FEIS into which it is incorporated provide information sufficient to show that the agency has insured that its actions are not likely to jeopardize the continued existence of listed species present in the project area or adversely modify or destroy designated critical habitat. Rather, the Biological Opinion and FEIS merely list concerns about negative impacts likely to result from the construction of the terminal groin proposed at Ocean Isle, and then determine without analysis that the project will not cause jeopardy or adverse modification of critical habitat. While we do not detail all of the flaws of the 2015 Biological Opinion here, we note that they are more than sufficient to raise questions about the Corps' ability to meet its legal duties under both the ESA and the CWA. As one glaring example, the Biological Opinion fails to assess the essential legal question of whether the project will impair the ability of sea turtles, piping plovers, red knots, and seabeach amaranth to recover to the point where they may be delisted. Instead, it repeatedly insinuates that the number of animals and amount of habitat likely to be affected by the project are modest relative to the population or critical habitat designation as a whole. Such a comparison does not serve to explain the impacts of the project on the species.

Response: The Corps concluded consultation with the USFWS on August 6, 2015 and has satisfied all requirements of section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

I.24. Comment: [T]he Timeline contained in the Biological Opinion at page 9 reflects the Corps' review and revisions to the Reasonable and Prudent Measures and Terms and Conditions imposed in the Biological Opinion. These revisions should be disclosed to the public as part of the NEPA process and the public's review of whether the Corps' permitting of the proposed project meets applicable conservation requirements under the ESA and CWA.

Response: The correspondence regarding the revisions to the Draft RPMs and T&Cs of the BO are presented in Appendix C of this document.

I.25. Comment: Both the Biological Opinion and the FEIS are clear that hardened structures that permanently stabilize and alter natural coastal dynamics are most harmful for each of these species and their habitats, including federally designated critical habitat. While there may be some benefits to addressing erosion on the affected beaches, the overall concern is that beach hardening, such as with the construction of the proposed terminal groin, will so harm coastal dynamics necessary for habitat maintenance that there will be long term impacts to each of these listed species.

Response: The proposed terminal groin is not anticipated to "harm coastal dynamics necessary for habitat maintenance". The design of the structure will not only retain material on the "updrift" side (thereby creating habitat for T&E species- turtles and plovers and red knots), but it will allow for material to pass over, through, and around the structure as well which will ensure that the downdrift beach (towards the inlet) will continue to receive material.

I.26. Comment: While the FWS included an Incidental Take Statement (ITS) in its Biological Opinion, it is wholly inadequate to meet its intended purpose...The ITS for each of the affected species and the critical habitat affected by the project limits the effect of the activity to 24,500 lf. Under the terms of the Biological Opinion, any amount of take or habitat disturbance within that area is allowed. Yet pursuant to the ESA's explicit requirements, FWS must have attempted to quantify the take expected to occur as a result of the proposed project, and if specific quantification was impossible, identify a surrogate that would provide a reasonable estimate.

Response: The Corps concluded consultation with the USFWS on August 6, 2015 and has satisfied all requirements of section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

I.27. Comment: For the reasons described above, the FEIS fails to meet the minimum requirements of NEPA and fails to provide the analysis of shoreline changes and environmental and natural resources impacts necessary to meet the Corps' obligations under the CWA or ESA. Before the Corps can legally move forward with this project it must issue a Supplemental EIS addressing the issues raised in these comments.

Response: The Corps has determined that the NEPA and CWA requirements have been satisfied.

Comments from the Environmental Protection Agency in a letter dated May 26, 2016:

J.1. Comment: Economic Benefits- The EPA reviewed Tables 3.10, 3.11, Chapter 5, and Appendix B and notes that these tables and Sections of the EIS only provide the reader with an understanding of the project cost for each alternative, not the economic benefit. Understanding the economic benefit of each alternative is critical for decision-making and important for the public to be able to understand the cost of each alternative and the potential economic benefit of each alternative. Additional review of Table 4.2 in Appendix B - Engineering Report - shows that $35,113,800 in damages to undeveloped parcels, structures, and other infrastructure is anticipated over a 30-year period if current management strategies are employed. The EPA also notes that the proposed project, Alternative 5 - Construction of a 750-ft. Terminal Groin, will cost $45,864,000 over a 30-year period to protect that expected losses under current management strategies. From the review of the relevant sections of the FEIS, it remains unclear from an economic standpoint how Alternative 5 would be the preferred alternative.

Response: Over the 30-year planning period, the total cost for Alternative 4 was estimated to be $53.15 million and $45.86 million for Alternative 5. Even though volume losses off the east end of Ocean Isle Beach could be reduced through repetitive dredging of the borrow area in the same location, the cost of Alternative 4 over the 30-year evaluation period exceeded the 30-year cost of Alternative 5 by about 16%.

J.2. Comment: Orientation of Shallotte Inlet- The response provided appears to be for another comment or the Corps misunderstood the EPA's comment on this issue. It is clear from the FEIS that the orientation of the Shallotte Inlet is a significant factor in erosion rates on the eastern end of OIB. In a response provided to another EPA comment it is stated that "During the formulation of the coastal storm damage reduction project, the USACE attributed much of the chronic erosion on the eastern portion of Ocean Isle Beach to changes in the orientation and position of the main ebb channel through Shallotte Inlet." Therefore, as stated in our comments on the DEIS, it remains unclear how the preferred alternative (construction of a terminal groin) is the solution to the erosion issues when the orientation of the inlet appears to be the primary cause.

Response: Alternative 4 was evaluated in the numerical model by simulating re-dredging of the Shallotte Inlet Borrow Area/Channel using modeled conditions at the end of Year 3 under Alternative 1 as a starting point. The model was then run for an additional 3 years to see if maintaining the borrow area/channel in a fixed location and alignment would produce accretion along the east end of Ocean Isle Beach. The results obtained by the model indicated volumetric losses off the east end of Ocean Isle Beach would be reduced during the 3 years following the second channel dredging operation. These results are described in Appendix B of the FEIS. The buildup of material on the west side of Shallotte Inlet was shown to be temporary due to the high erosion rate on the extreme east end of Ocean Isle Beach. Therefore, in regards to the purpose and needs of maintaining shore protection on the east end of the island, Alternative 4 does not perform as well as Alternative 5.

The terminal groin alternative is the least environmentally damaging practicable alternative. The CSDRP maintenance cycle is currently every 3 years. With the construction of the terminal groin alternative, the CSDRP maintenance cycle is anticipated to be reduced to approximately every 5 years thereby reducing impacts within the placement area to nesting sea turtles, shorebirds (nesting, resting, and foraging), infaunal communities, etc. In addition, with dredging only occurring approximately every 5 years (rather than every 3 years), the infaunal community within the footprint of the borrow area within Shallotte Inlet would have more time to recover and there would be less frequent impacts to larval, juvenile, and adult finfish and other aquatic species. The FEIS is clear in demonstrating that Alternative 4 will result in increased environmental impacts and increased cost compared to Alternative 5. Environmental impacts would be higher for Alternative 4 in part due to the increased maintenance requirement (approximately every 4 years) opposed to approximately every 5 years under Alternative 5.

J.3. Comment: Sea Level Rise (SLR)- The EPA remains concerned about the potential impact of sea-level rise on the proposed project and the project area. In 2015, the N.C. Coastal Resources Commission Science Panel updated their 2010 Study on NC and sea-level rise. The EPA recommends the Corps evaluate this recent report and the predicted sea-level rise in the project area prior to issuance of the Record of Decision (ROD). It is also unclear from the review and comments provided in the

FEIS if the Corps modeled for storm surge conditions and how these conditions would impact the proposed project. The Corps has a model for calculating storm surge, i.e., Coastal Storm Modeling System, the Coastal 2D (horizontal) steady-state near SHORE morphology response model (CSHORE), and the Advanced Circulation (ADCIRC) model to simulate the effects of storm surge and circulation have on inundation, flooding, sediment transport and beach erosion. The EPA recommends that the Corps evaluate the impacts of storm surge on the project area and proposed project prior to issuance of the ROD.

Response: Chapter 5 of the FEIS addresses the impacts of Sea Level Change with literature cited. It states that no direct or indirect impacts from any of the project alternatives are expected. However, the project alternatives involving beach nourishment may help protect from these cumulative impacts.

While the Corps agrees that any additional data, including sea level rise and storm surge data would help in the evaluation of those impacts to all proposed alternatives, these data would have needed to be disclosed in the Draft EIS. To require the Applicant to complete additional modeling after the issuance of the Final EIS would create undo financial burden and delay. The Corps believes that the evaluation of all alternatives as presented in the EIS is sufficient, as all alternatives were evaluated for their ability to mitigate for long-term erosion.

J.4. Comment: Consideration of Climate Change and Greenhouse Gas (GHG) Emissions In future analyses, the EPA recommends that the Corps estimate the direct and indirect GHG emissions caused by the proposal and its alternatives, including construction and operation emissions. Examples of tools for estimating and quantifying GHG emissions can be found on CEQ's website. These emissions levels can serve as a reasonable proxy for climate change impacts when comparing the alternatives and considering appropriate mitigation measures. The EPA recommends that future NEPA analyses describe measures to avoid, reduce, and compensate for GHG emissions caused by the proposal, including reasonable alternatives and other practicable mitigation opportunities, and disclose the estimated associated GHG reductions. For example, the Corps could consider fuel-efficient construction machinery. For this project, the EPA also recommends that the Corps consider commitments in the ROD to implement reasonable mitigation measures that would reduce project-related GHG emissions.

Response: As discussed in the EIS, impacts to air quality associated with the project would be temporary and short term. The use of machinery for the construction of the groin, dredging and beach fill activities would result in temporary increases in pollution to the ambient air, but the activities are not anticipated to affect compliance with the National Ambient Air Quality Standard (NAAQS). Any later indirect emissions are generally not within the Corps' continuing program responsibility and generally cannot be practicably controlled by the Corps. For these reasons a conformity determination is not required for this permit action. Chapter 4 of the FEIS (Non-Relevant Resources) states that it is not expected that any activities associated with the proposed project alternatives would significantly contribute to air pollution within the permit area.

J.5. Comment: Parcels Protected by Project-The EPA has reviewed Figure 3. 1 and Appendix B Figure 4. 1. Based on our review of the material provided in the FEIS, the predicted shoreline landward retreat (by 2045) endangers approximately 50 structures and approximately 30 undeveloped parcels. The EPA remains very unclear where the 155 parcels cited in the Corps response are located. In addition, the Corps continues to use the 238 parcel number in the executive summary and throughout the FEIS. One example, it is stated on page 155 of the FEIS that, "Based on Delft3D and other analysis, there are currently 238 parcels and 45 homes east of station 15+00 that are vulnerable to erosion damage over the next 30 years should the past erosion trends continue." A further review of Brunswick County GIS data show more than 80 parcels located off the eastern end of OIB that are already submerged (Please see the attached map). If any of these parcels are actually being counted as 'protected parcels' by the proposed project, this should have been fully disclosed during the NEPA process. In addition, if new development is being proposed on the eastern end of OIB, the cumulative impact of this additional development should also have been disclosed during the NEPA process. The EPA considers these issues vital to an objective decision-making process. Therefore, the EPA believes that these issues need to be fully disclosed in the ROD to ensure that the public and other stakeholders are clear on how and why the preferred alternative was selected.

Response: Additional information regarding the number of parcels susceptible to erosion has been provided in Appendix D of this document. As of the date of this ROD, no new development is currently being proposed on the eastern end of Ocean Isle Beach. One potential project called “The Point at Ocean Isle Beach” was proposed to the NC Division of Coastal Management during a scoping meeting on February 29, 2016. The proposal did consist of placing residential structures on uplands down drift of the proposed terminal groin. Once this fact was pointed out in the meeting, the potential applicant withdrew the proposal and no further plans of development have been indicated to any agency.

J.6. Comment: Mitigation Commitments-The EPA supports the inclusion of the mitigation measures agreed to in all consultation efforts for this proposed project in the ROD.

Response: Comment noted.

J.7. Comment: The EPA continues to have concerns that the specific terms and conditions of monitoring for this project have not been fully disclosed in the DEIS or FEIS. The EPA supports having specific terms and conditions for monitoring in the ROD because they will be legally binding. However, the public and reviewing agencies have not been afforded the opportunity to view and comment on the proposed monitoring conditions. The EPA also has concerns that the response for turbidity monitoring uses the term: "if required." Implementing a turbidity monitoring plan is essential to ensuring compliance with the State water quality standards during project construction activities. The EPA recommends that a clear commitment to turbidity monitoring be included in the ROD.

Response: A turbidity limit condition similar to the State condition of 25 NTUs (Nephelometric Turbidity Units) as described in 15 A NCAC 028 .0200 will be included in any DA authorization. There will also be a turbidity monitoring requirement where the monitoring protocols must be provided to the Wilmington Regulatory Field Office for review 30 days prior to project commencement. Appropriate sediment and erosion control practices must be used to meet this standard.

J.8. Comment: The EPA appreciates the additional clarification and information provided in Chapter 6 related to beach profile monitoring and thresholds that will be used to determine the terminal groin's impact on shorelines in the vicinity of the project. The EPA recommends these monitoring conditions be included in the ROD.

Response: The monitoring conditions will be included as special conditions of any authorization.

J.9. Comment: List of Preparers- Section 1502.17 of the Council on Environmental Quality regulations specifically requires the identification of the names and qualifications of persons who were primarily responsible for preparing the EIS or significant background papers, including basic components of the statement. The EPA notes that the FEIS does not include a list of preparers. The EPA recommends that the list of preparers also be included in the ROD.

Response: Appendix B of this document provides a list of prepares for the FEIS.

Appendix B

List of Preparers of the Final Environmental Impact Statement

List of Preparers

Name	Responsibility	Qualifications
James Jarrett, P.E.	Project Manager/Coastal Engineering. Alternatives Design and Analysis	B.S. Civil Engineering; M.S. Civil Engineering. 47 years of experience with coastal engineering and coastal protection project design along with project management.
Gordon Thompson, P.E.	QA/QC/Coastal Engineer	B.S Civil Engineering, M.S, Coastal Engineering. 15 years of experience with the design, permitting and construction oversight of major beach restoration projects.
Andy Wycklendt, P.E.	Coastal Engineer. Numerical Modeling	B.S. Ocean Engineering, M.S. Ocean and Resources Engineering. 12 years of experience modeling coastal processes, design and construction of coastal restoration and shoreline protection projects.
Heather Vollmer	Geographic Information Systems (GIS) Analyst. Environmental Consequences, Graphics	B.S., Environmental Studies; M.S. Environmental Studies. 16 years of experience in GIS database development and management.
Brad Rosov	Project Biologist, Affected Environment, Environmental Consequences	B.A. Biology; M.S. Marine Biology. 8 years of experience in permitting, environmental documentation, NEPA, habitat assessments, and endangered species evaluations.
Greg Finch	Biologist. Affected Environment, Environmental Consequences.	B.A. Environmental Science. 13 years of experience in permitting, environmental documentation, NEPA, habitat assessments, and endangered species evaluations.
Ken Willson	Geologist. Geotechnical Report	B.S. Earth Science, M.S. Geology. 11 years of experience in geophysical surveying and geotechnical assessments.
Gordon Watts	Marine Archeologist. Cultural Resources Report.	B.A, History, M.A., History, PhD, Maritime History and Nautical Archaeology. 40+ years of experience in underwater target assessment, cultural resource management/mitigation studies, and historic shipwreck mapping.

Tyler Crumbley	Regulatory Project Manager, U.S. Army Corps of Engineers Wilmington District Regulatory Division. Review EIS for compliance with NEPA.	B.S. Natural Resources, M.S. Hydrology. Professional Wetland Scientist (PWS) Certified. 10 years of experience in environmental documentation and regulatory permitting review.
Dale Beter	Wilmington Field Office Chief, U.S. Army Corps of Engineers Wilmington District Regulatory Division. Review EIS for compliance with NEPA.	M.S. Ecology. Professional Wetland Scientist (PWS) Certified. 20 years of experience in regulatory permitting review.
Carl Pruitt	Assistant District Counsel, U.S. Army Corps of Engineers Wilmington District Office of Counsel. Review EIS for compliance with NEPA.	JD School of Law; B.A. 12 years of legal experience with the U.S. Army Corps of Engineers.

Appendix C

Correspondence and Changes to RPMs and T&Cs for USFWS BO

From:	Rosov, Brad
To:	Crumbley, Tyler SAW
Subject:	RE: [EXTERNAL] Final BO for Ocean Isle Beach
Date:	Friday, August 21, 2015 2:55:21 PM

Thanks, Tyler...

-----Original Message-----
From: Crumbley, Tyler SAW [mailto:Tyler.Crumbley@usace.army.mil]
Sent: Friday, August 21, 2015 1:54 PM
To: Rosov, Brad
Subject: FW: [EXTERNAL] Final BO for Ocean Isle Beach

I've read it and nothing really stood out.

-----Original Message-----
From: Matthews, Kathryn [mailto:kathryn_matthews@fws.gov]
Sent: Thursday, August 06, 2015 4:11 PM
To: Crumbley, Tyler SAW
Subject: [EXTERNAL] Final BO for Ocean Isle Beach

Hi Tyler,

Please find attached an e-copy of the Final BO (and cover letter) for the Ocean Isle Terminal Groin project. A hard copy will be in the mail tomorrow.

Unfortunately, when I turned the BO into a PDF, it messed the page breaks up a little bit. However, all of the text is still there.

Although we have finalized the BO, it does not impact our ability to comment on any future PNs or the EIS or other environmental documents.

Let me know if you have any questions. Have a good weekend,

--

Kathy Matthews
Fish and Wildlife Biologist
Raleigh Ecological Services
U.S. Fish and Wildlife Service
P.O. Box 33726
Raleigh, NC 27636-3726
Phone 919-856-4520 x27
Email kathryn_matthews@fws.gov

FWS.GOV/RALEIGH | Facebook | YouTube | Flickr |

From:	Matthews, Kathryn
To:	Crumbley, Tyler SAW
Subject:	Re: FW: [EXTERNAL] Draft RPMs and Terms and Conditions for Ocean Isle Beach Terminal Groin project
Date:	Tuesday, July 21, 2015 4:01:36 PM

Sounds good - I hope to finish drafting the BO this week and get it on Pete's desk on Monday for his review. We should be on track to have it to you by 8/7.

Thanks,
Kathy

On Tue, Jul 21, 2015 at 3:58 PM, Crumbley, Tyler SAW <Tyler.Crumbley@usace.army.mil <mailto:Tyler.Crumbley@usace.army.mil> > wrote:

Kathy. I have nothing to add or subtract from what you provided. From what I hear, that is the only change that they wanted to talk about.

Thank you very much.

-Tyler

-----Original Message-----
From: Matthews, Kathryn [mailto:kathryn_matthews@fws.gov <mailto:kathryn_matthews@fws.gov>]
Sent: Monday, July 20, 2015 1:57 PM
To: Crumbley, Tyler SAW
Subject: Re: FW: [EXTERNAL] Draft RPMs and Terms and Conditions for Ocean Isle Beach Terminal Groin project

RPM #6 has been changed to:

Staging areas for earth-moving equipment must be located off the beach during the early (April 15 through April 30) and late (November 16 through November 30) portions of the nesting season. Nighttime storage of earth-moving equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. All excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day.

Term and Condition #6 has been changed to:

1. Staging areas for earth-moving equipment must be located off the beach during the early (April 15 through April 30) and late (November 16 through November 30) portions of the nesting season. Nighttime storage of earth-moving equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. All excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day. During any periods when excavated trenches must remain on the beach at night, nighttime sea turtle monitoring by the sea turtle permit holder will be required in the project area in order to further reduce possible impacts to nesting and hatchling sea turtles. Nighttime monitors will record data on false crawls, successful nesting, and any additional activities of nesting or hatchling sea turtles in the project area.

Let me know what you think. Do you think that is the only change?

thanks,
Kathy

On Fri, Jul 17, 2015 at 4:08 PM, Crumbley, Tyler SAW <Tyler.Crumbley@usace.army.mil
<mailto:Tyler.Crumbley@usace.army.mil> > wrote:

You too.

-----Original Message-----
From: Matthews, Kathryn [mailto:kathryn_matthews@fws.gov <mailto:kathryn_matthews@fws.gov>]
Sent: Friday, July 17, 2015 4:06 PM
To: Crumbley, Tyler SAW
Subject: Re: FW: [EXTERNAL] Draft RPMs and Terms and Conditions for Ocean Isle Beach Terminal Groin project

You can recommend wording if you like - otherwise I can come up with something.

Thanks,and have a good weekend,

On Fri, Jul 17, 2015 at 4:05 PM, Crumbley, Tyler SAW <Tyler.Crumbley@usace.army.mil
<mailto:Tyler.Crumbley@usace.army.mil> > wrote:

I can help with the wording if you want.

-----Original Message-----
From: Matthews, Kathryn [mailto:kathryn_matthews@fws.gov
<mailto:kathryn_matthews@fws.gov>]
Sent: Friday, July 17, 2015 4:02 PM
To: Crumbley, Tyler SAW
Subject: Re: FW: [EXTERNAL] Draft RPMs and Terms and Conditions for Ocean Isle Beach Terminal Groin project

Sure.

On Fri, Jul 17, 2015 at 4:01 PM, Crumbley, Tyler SAW <Tyler.Crumbley@usace.army.mil
<mailto:Tyler.Crumbley@usace.army.mil> > wrote:

Kathy,

Can we change the RPM #6 to specifically state "earth moving" equipment and allow for the pipeline to stay in place?

Thank you.

-Tyler

-----Original Message-----
From: Rosov, Brad [mailto:Brad.Rosov@cbi.com <mailto:Brad.Rosov@cbi.com>]
Sent: Friday, July 17, 2015 11:17 AM
To: Crumbley, Tyler SAW; 'mayor@oibgov.com <mailto:mayor@oibgov.com> '
Cc: 'Daisy Ivey'; Beter, Dale E SAW
Subject: RE: [EXTERNAL] Draft RPMs and Terms and Conditions for Ocean Isle Beach Terminal Groin project

Tyler,

Thank you for giving the Town the opportunity to review these proposed Terms and Conditions and RMPs drafted by the USFWS. After careful review, the Town is in agreement with them and is poised to comply with each of the items described within. It has been requested, however, that the RMP #6 pertaining to Sea Turtles should be amended for further clarification. Currently, this RMP states:

"Staging areas for construction equipment must be located off the beach during the early (April 15 through April 30) and late (November 16 through November 30) portions of the nesting season. Nighttime storage of construction equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. All excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day."

After speaking with Kathy Matthews, she informed us that the intent of this RMP is to limit the presence of earth moving equipment (such as backhoes or front end loaders) on the beach over night while sea turtles may crawl onto the beach in an attempt to nest. We would therefore request that this RMP is modified to reflect the fact that the equipment to be kept off the beach will be limited to earth moving equipment. Other equipment, such as the pipeline, would still be permitted to be on the beach subject to their positioning close to the dune line or upper portion of the dry beach.

Please work with Kathy to see if she is willing to change the language of this RMP in an attempt to provide better clarification on this issue. Of course, give me a call any time to discuss if need be.

Regards,

Brad Rosov
Scientist IV
Coastal, Ports & Marine
Environmental & Infrastructure
Tel: +1 910 791 9494
Cell: +1 910 352-1555
Fax: +1 910 791 4129
brad.rosov@CBI.com

CB&I
4038 Masonboro Loop Rd.
Wilmington, NC 28409
United States
www.CBI.com <http://www.CBI.com>

-----Original Message-----
From: Crumbley, Tyler SAW [mailto:Tyler.Crumbley@usace.army.mil <mailto:Tyler.Crumbley@usace.army.mil>]
Sent: Monday, July 13, 2015 2:22 PM
To: mayor@oibgov.com <mailto:mayor@oibgov.com>
Cc: Daisy Ivey; Rosov, Brad; Beter, Dale E SAW
Subject: FW: [EXTERNAL] Draft RPMs and Terms and Conditions for Ocean Isle Beach Terminal Groin project

Ms. Smith,

As the applicant for the proposed Terminal Groin at OIB, I am forwarding you a copy of the proposed Terms and Conditions from the USFWS. Please read the email below and the attachments carefully. If unchanged, these conditions will be included as special conditions to the Department of the Army permit if authorized. We will be conducting our own review of these RPMs and Terms and Conditions as well to ensure compliance with them is possible. Please respond back to me promptly with any issues that arise from your review.

Thank you.

-Tyler

Tyler Crumbley
Project Manager
U.S Army Corps of Engineers-Wilmington District Wilmington Regulatory Field Office
69 Darlington Avenue
Wilmington, NC 28403

Phone: 910-251-4170
Fax: 910-251-4025
email: tyler.crumbley@usace.army.mil <mailto:tyler.crumbley@usace.army.mil>

"The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete the Customer Satisfaction Survey located at: http://regulatory.usacesurvey.com/"

-----Original Message-----
From: Matthews, Kathryn [mailto:kathryn_matthews@fws.gov <mailto:kathryn_matthews@fws.gov>]
Sent: Friday, July 10, 2015 2:06 PM
To: Crumbley, Tyler SAW; Dunn, Maria T.; Godfrey, Matthew H
Cc: John Ellis; Pete Benjamin; AnnMarie Lauritsen
Subject: [EXTERNAL] Draft RPMs and Terms and Conditions for Ocean Isle Beach Terminal Groin project

Hi Tyler,

Attached please find a set of draft Reasonable and Prudent Measures (RPMs) and Terms and Conditions for the Ocean Isle Beach Terminal Groin Project. I am also attaching the appendices to the draft BO for your info. As a reminder, the BO is due by August 7, so an expedited review would be much appreciated.

Please let me know if you have concerns or questions.

Thanks, and have a good weekend.

--

Kathy Matthews
Fish and Wildlife Biologist
Raleigh Ecological Services
U.S. Fish and Wildlife Service
P.O. Box 33726
Raleigh, NC 27636-3726
Phone 919-856-4520 x27
Email kathryn_matthews@fws.gov <mailto:kathryn_matthews@fws.gov>

FWS.GOV/RALEIGH <http://FWS.GOV/RALEIGH> <http://www.fws.gov/raleigh> | Facebook <https://www.facebook.com/pages/USFWS-in-North-Carolina/127502634126752> | YouTube

<http://www.youtube.com/channel/UCMqPAPfBGsDMs2UiD-5Tbbg> | Flickr
<http://www.flickr.com/photos/usfwssoutheast/collections/72157634196660344/> |

This e-mail and any attached files may contain CB&I (or its affiliates) confidential and privileged information. This information is protected by law and/or agreements between CB&I (or its affiliates) and either you, your employer or any contract provider with which you or your employer are associated. If you are not an intended recipient, please contact the sender by reply e-mail and delete all copies of this e-mail; further, you are notified that disclosing, copying, distributing or taking any action in reliance on the contents of this information is strictly prohibited.

--

Kathy Matthews
Fish and Wildlife Biologist
Raleigh Ecological Services
U.S. Fish and Wildlife Service
P.O. Box 33726
Raleigh, NC 27636-3726
Phone 919-856-4520 x27
Email kathryn_matthews@fws.gov <mailto:kathryn_matthews@fws.gov>

FWS.GOV/RALEIGH <http://FWS.GOV/RALEIGH> <http://www.fws.gov/raleigh> | Facebook
<https://www.facebook.com/pages/USFWS-in-North-Carolina/127502634126752> | YouTube
<http://www.youtube.com/channel/UCMqPAPfBGsDMs2UiD-5Tbbg> | Flickr
<http://www.flickr.com/photos/usfwssoutheast/collections/72157634196660344/> |

--

Kathy Matthews
Fish and Wildlife Biologist
Raleigh Ecological Services
U.S. Fish and Wildlife Service
P.O. Box 33726
Raleigh, NC 27636-3726
Phone 919-856-4520 x27
Email kathryn_matthews@fws.gov <mailto:kathryn_matthews@fws.gov>

FWS.GOV/RALEIGH <http://FWS.GOV/RALEIGH> <http://www.fws.gov/raleigh> | Facebook
<https://www.facebook.com/pages/USFWS-in-North-Carolina/127502634126752> | YouTube
<http://www.youtube.com/channel/UCMqPAPfBGsDMs2UiD-5Tbbg> | Flickr
<http://www.flickr.com/photos/usfwssoutheast/collections/72157634196660344/> |

--

Kathy Matthews
Fish and Wildlife Biologist
Raleigh Ecological Services
U.S. Fish and Wildlife Service
P.O. Box 33726
Raleigh, NC 27636-3726
Phone 919-856-4520 x27
Email kathryn_matthews@fws.gov <mailto:kathryn_matthews@fws.gov>

FWS.GOV/RALEIGH <http://FWS.GOV/RALEIGH> <http://www.fws.gov/raleigh> | Facebook <https://www.facebook.com/pages/USFWS-in-North-Carolina/127502634126752> | YouTube <http://www.youtube.com/channel/UCMqPAPfBGsDMs2UiD-5Tbbg> | Flickr <http://www.flickr.com/photos/usfwssoutheast/collections/72157634196660344/> |

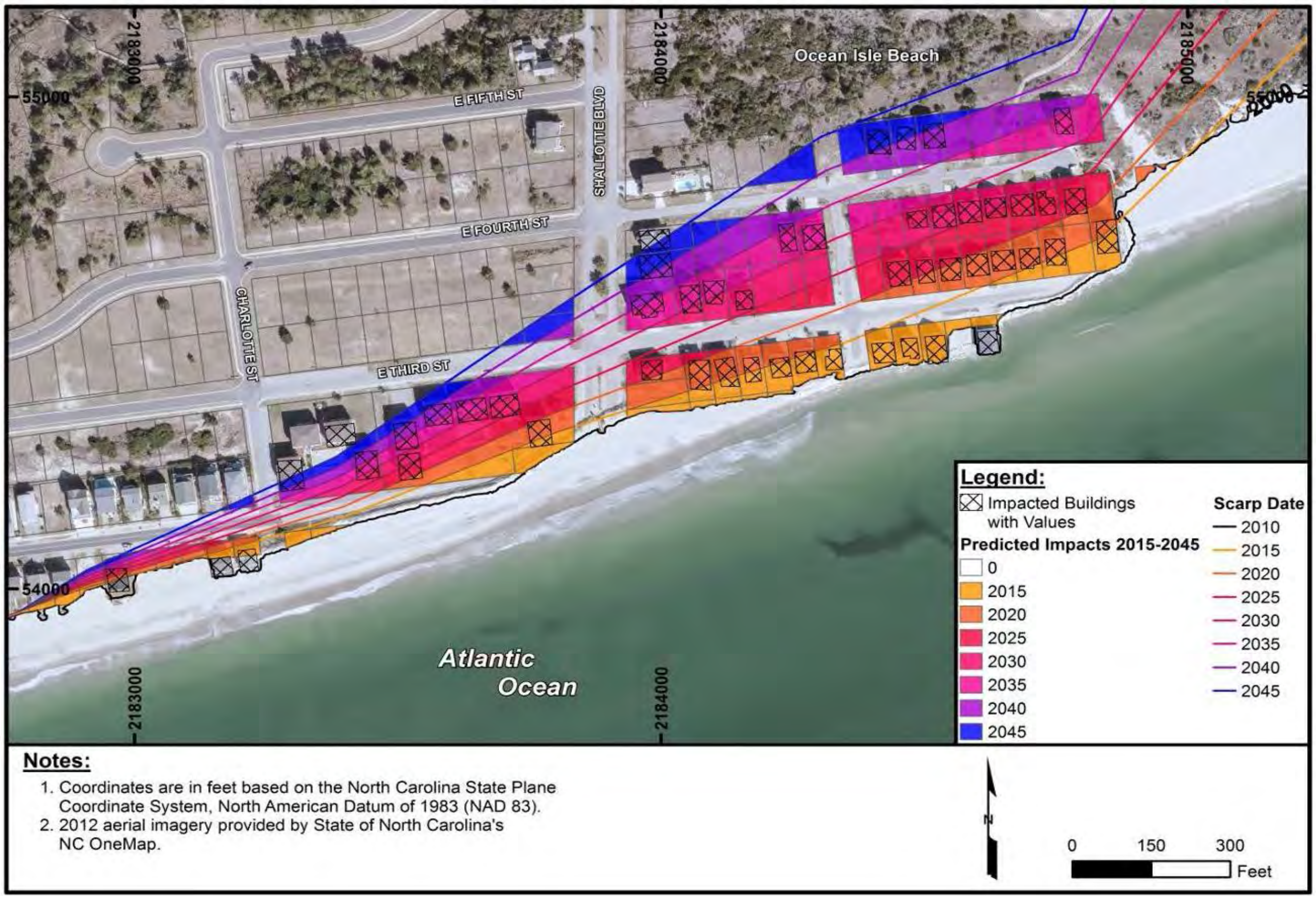
--

Kathy Matthews
Fish and Wildlife Biologist
Raleigh Ecological Services
U.S. Fish and Wildlife Service
P.O. Box 33726
Raleigh, NC 27636-3726
Phone 919-856-4520 x27
Email kathryn_matthews@fws.gov <mailto:kathryn_matthews@fws.gov>

FWS.GOV/RALEIGH <http://www.fws.gov/raleigh> | Facebook <https://www.facebook.com/pages/USFWS-in-North-Carolina/127502634126752> | YouTube <http://www.youtube.com/channel/UCMqPAPfBGsDMs2UiD-5Tbbg> | Flickr <http://www.flickr.com/photos/usfwssoutheast/collections/72157634196660344/> |

<u>Appendix D</u>

Additional Information Regarding Parcels Used for Analysis



<u>Figure 2. Overall parcel map used in economic analysis.</u>

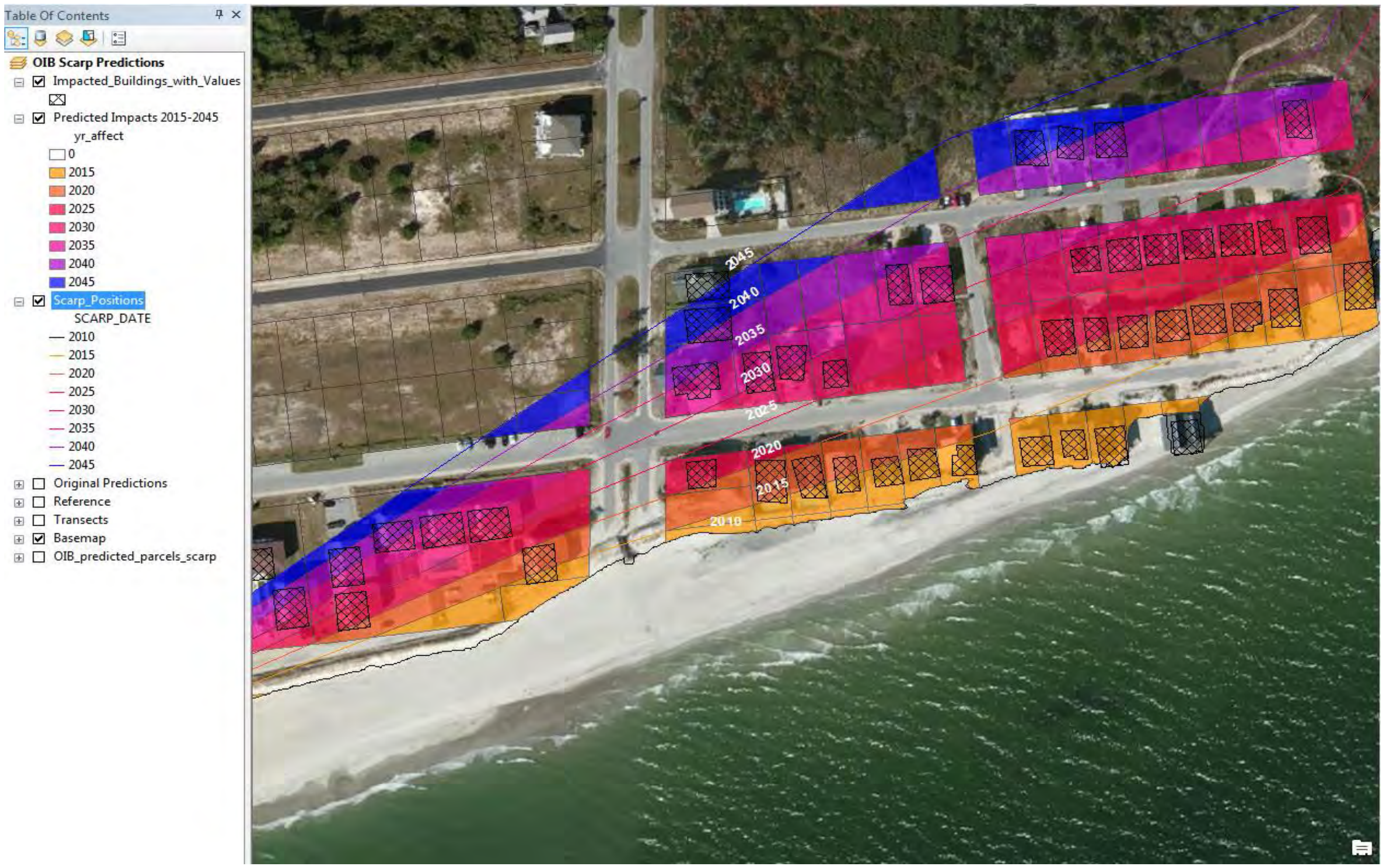


Figure 2. Expanded parcel map showing parcel lines obtained from Brunswick County GIS.

Predicted Property and Structure Loss 2010-2045 (revised April 2015 to excluce parcels with value less than $2000)								
	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	Cumulative
Estimated Shoreline Length	1800	2076	2250	2064	2327	2421	1819	
Total Acerage Lost	0.82	0.95	1.03	0.94	1.06	1.11	0.83	6.74
Value of Parcels Lost	$877,000	$1,638,000	$2,095,000	$1,994,000	$4,039,000	$5,638,000	$5,077,000	$21,358,000
Number parcels	14	20	22	22	26	27	24	155
# of Buildings Impacted		23	8	5	4	1	4	45
Value of Impacted Buildings		$2,136,000	$741,000	$440,000	$388,000	$92,000	$385,000	$4,182,000

Table 1. Predicted Parcel Loss Summary.

Table 1. Depicts the number of parcels impacted during each model period with a cumulative amount over all modeling periods of 155 parcels in total. This value changed from the 238 initially disclosed in the DEIS. As the predicted escarpment line moved further inland during each five year modeling period, additional parcels were impacts. The total number of impacted parcels used for the updated analysis within the FEIS was 155 parcels.

Pg. 26 of the FEIS reads: "Based on tax information available from the Brunswick County GIS, there are 155 parcels east of station 15+00 (located just west of Shallotte Boulevard) with a tax value of $2,000 or greater, 45 of which have homes. Parcels with values less than $2,000 are non-conforming (i.e., cannot meet existing NC DCM setback requirements) and are not included in the analysis. All of these parcels and homes are vulnerable to erosion damage over the next 30 years should the past erosion trends continue are shown on Figure 3.1. In addition, over 1,800 feet of roads and associated utilities could also be damaged or lost over this 30-year timeframe. Of the 45 homes at risk, 18 are considered to be located on the oceanfront row, 12 on the second row, and the remaining 15 farther back on the 3rd and 4th rows."

Appendix E

Discount Rate Resource

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

CECW-P

15 October 2014

MEMORANDUM FOR PLANNING COMMUNITY OF PRACTICE

SUBJECT: Economic Guidance Memorandum, 15-01, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2015

The enclosed information is provided for immediate use. Please note that the interest rate to prioritize for budget development is discussed in the annual Program Development Guidance issued by the Programs Integration Division, not this EGM.

Questions related to this memorandum should be addressed to Mr. Bruce Carlson, CECW-P, at bruce.d.carlson@usace.army.mil or by telephone at (202) 761-4703.

Bruce D. Carlson
Acting Deputy Chief,
Planning and Policy Division
Directorate of Civil Works

5 Enclosures

1. Federal Discount Rate
2. Deferred Payment Interest Rates
3. Water Supply Interest Rates
4. Hydropower Interest Rate
5. Delinquent Payment Collection Rate

Federal Discount Rate for Fiscal Year 2015

Project Evaluation and Formulation Rate (Discount Rate): FY 2015 – 3.375 %

The Principles and Guidelines states: "Discounting is to be used to convert future monetary values to present values. Calculate present values using the discount rate established annually for the formulation and economic evaluation of plans for water and related land resources." (Section 1.4.11)

The interest rate for discounting, that is, converting benefits and costs to a common time basis, is set each fiscal year in accordance with Section 80 of Public Law 93-251. HQUSACE obtains the rate from U.S. Department of the Treasury, which computes it as the average market yield on interest-bearing marketable securities of the United States that have 15 or more years remaining to maturity. The computed rate is effective as of 1 October of each year. It is based on yield data for the entire previous fiscal year, and thus the discount rate for the fiscal year above is based on average yields during the previous fiscal year. According to law the rate may not be raised or lowered more than one quarter of one percentage point in any year.

The table below shows the discount rate historical series going back to 1957. Column headings identify the source of authority for the rates, and not necessarily the organization that actually computed the rates.

Federal Discount Rate for Fiscal Year 2015

FEDERAL DISCOUNT RATES FOR PROJECT FORMULATION AND EVALUATION					
Fiscal Year	Bureau of the Budget (now OMB) Circular A-47	Senate Document No. 97 (1962)	Water Resources Council (WRC) (1968)	Principles & Standards (WRC 1973)	Section 80 WRDA 1974 (Public Law 93-251)
1957-60	2.500%				
1961	2.625%				
1962	2.625%	2.625%			
1963		2.875%			
1964		3.000%			
1965-67		3.125%			
1968		3.250%			
1969		3.250%	4.625%		
1970			4.875%		
1971			5.125%		
1972			5.375%		
1973			5.500%		
1974			5.625%	6.875%	5.625%
1975					5.875%
1976					6.125%
1977					6.375%
1978					6.625%
1979					6.875%
1980					7.125%
1981					7.375%
1982					7.625%
1983					7.875%
1984					8.125%
1985					8.375%
1986					8.625%
1987					8.875%
1988					8.625%
1989					8.875%
1990					8.875%
1991					8.750%
1992					8.500%
1993					8.250%
1994					8.000%
1995					7.750%
1996					7.625%
1997					7.375%
1998					7.125%
1999					6.875%
2000					6.625%
2001					6.375%
2002					6.125%
2003					5.875%
2004					5.625%
2005					5.375%
2006					5.125%
2007					4.875%
2008					4.875%
2009					4.625%
2010					4.375%
2011					4.125%
2012					4.000%
2013					3.750%
2014					3.500%
2015					**3.375%**

Deferred Payment Interest Rates and Payment Calculations for Fiscal Year 2015

Normally a non-Federal sponsor is expected to provide its cost share as the funds are needed, that is, as construction proceeds. Under some conditions, a sponsor may seek to defer payment until after construction completion. When payments are deferred, they are made with interest. This enclosure provides interest rates to use in determining the deferred payments, and instructions for computing them.

The necessary conditions for formally seeking deferred payments are verifiable sponsor need and prior concurrence by the ASA (CW). In principle, deferred payments are available for all project authorities (purposes). In practice, because of Corps budget constraints that preclude it from making what are, in effect, loans to sponsors, the Corps finds it difficult to participate in many projects with deferred payments.

There is some flexibility to accommodate limited deferred payments for harbor improvement projects; deferred payments are limited to the 'additional' ten percent sponsor obligation for General Navigation Features (GNF) costs. This 'additional' ten percent GNF cost share is typically a minor portion of a sponsor's total project cost share.

Authority for sponsor-deferred payments is PL 99-662 (WRDA '86). Provision for deferred payments for flood control and most other project purposes are in Section 103, paragraphs (a)(4), (b), and (k). Authority for deferral of 'additional' ten percent GNF costs is in Section 101, paragraph (a)(2).

In the table below, "Interest Rates for Computing Non-Federal Repayments", the interest rates are based on Section 106 of WRDA '86, which says that the interest rate applicable to deferred payments will be the yield on Treasury securities having a remaining period to maturity the same as the repayment period selected (and agreed to by ASA (CW)). Thus, if the agreed upon repayment period is twelve years the repayment interest rate will be the yield on securities with twelve years left until maturity.

A detailed discussion of deferred payments and cost sharing is in ER 1165-2-131, Local Cooperation Agreements for New Start Construction Projects. This ER implements the cost sharing provisions of WRDA '86, and the instructions below, which are continued from previous editions of this EGM, presume knowledge of the ER.

I. **Interest on Deferred Payments**

A. **Deferred payment reimbursed during the construction period**. Interest will be charged on each Federal expenditure made in lieu of non-Federal contributions for the period between the expenditure and the reimbursement, except as noted in paragraph E. below.

B. **Deferred payments reimbursed over a period of time following completion of construction** (reference Sections 103(a)(4), 103(b), and 103(k) of P.L.99-662). Interest will be charged for each Federal expenditure (first costs) made in lieu of non-Federal contributions for the period between the expenditure and the end of construction. The first costs plus this interest will then be amortized over the selected repayment period.

C. **Repayment under section 101(a)(2) of P.L.99-662**. Repayment of up to 10 percent required under this section will not include any interest for the construction period only.

D. **Interest Computation**. Expenditures each month will be totaled and interest computed as though all the expenditures were made at the mid-point of the month. Interest will be compounded annually on the anniversary of the expenditure. Periods of less than one year will be converted to a fraction of a year (interest charge = principal at beginning of period x interest rate x fraction of a year).

E. **Delay of initial payment under sections 101(d) and 103(l) of P.L.99-662**. Delayed initial payments for up to one year approved by the ASA (CW) shall be assessed interest for one-half the period of delay.

II. **Rate of interest to be applied to deferred payments**

A. **Reimbursements during the construction period**. The interest rate will be determined by using the formula specified in section 106 of P.L.99-662. The maturity period shall be equal to length of time between the Federal expenditure and the reimbursement.

B. **Reimbursement after completion of construction**. The rate of interest to be used in computing interest for the construction period and to amortize the total obligation at the start of the repayment period (first cost plus interest) will be the rate determined using the formula in section 106 of P.L.99-662. For example, when the repayment period is 30 years, the interest rate shall be determined by the Secretary of the Treasury, taking into consideration the average market yields on outstanding marketable obligations of the United States with remaining periods of maturity of 30 years during the month preceding the fiscal year in which costs for the construction of the project are first incurred **plus a premium of one-eighth of one percentage point for transaction costs.**

III. **Payment Schedule**. The payments, where reimbursement is made after completion of construction, shall be in equal consecutive annual installments, the first of which shall be due and payable within 30 days after the non-Federal interest is notified by the District Commander that the project or project modification is completed and operational for the purpose(s) for which repayment is being made. Annual installments thereafter will be due and payable on the anniversary date of the date of notification. Except for the first payment, which will be applied solely to the retirement of principal, all installments shall include accrued interest on the unpaid balance at the rate provided above. The last installment shall be adjusted upward or downward when due to assure repayment of all of the indebtedness.

IV. **Five-Year Recalculation of the Interest Rate Applicable to Deferred Payments**. The formula used to determine the interest rate under paragraph II.B above will be used for each recalculation. For example, if the original maturity period is 30 years, then the interest rate for each recalculation will use the current Fiscal Year interest rate for 30 years. Annual payments, however, will be based on the remaining repayment period.

V. **Expenditures between Feasibility Studies and Construction**. Federal expenditures not covered by the FCSA for feasibility studies and made prior to the PCA for construction (PED) will be treated as first year construction costs subject to interest charges based on the preceding paragraphs as though the expenditures were made at the beginning of the first year of construction.

VI. **Projects Authorized for Planning, Engineering, and Design**. Planning and engineering will be cost shared 50-50 in accordance with Section 105(b) of P.L.99-662. Expenditures for design will be treated in accordance with paragraph V. above.

Deferred Payment Interest Rates Fiscal Year 2015

Interest Rates for Computing Non-Federal Repayments
Fiscal Year 2015
(Section 106 of P.L. 99-662)

From and Including	Up To But Not Including	Rate
0 years - 3 months	1 year - 3 months	1/8%
1 year - 3 months	1 year - 7 months	1/4%
1 year - 7 months	1 year - 10 months	3/8%
1 year - 10 months	2 years - 1 month	1/2%
2 years - 1 month	2 years - 4 months	5/8%
2 years - 4 months	2 years - 7 months	3/4%
2 years - 7 months	2 years - 10 months	7/8%
2 years - 10 months	3 years - 2 months	1%
3 years - 2 months	3 years - 5 months	1-1/8%
3 years - 5 months	3 years - 9 months	1-1/4%
3 years - 9 months	4 years - 1 month	1-3/8%
4 years - 1 month	4 years - 6 months	1-1/2%
4 years - 6 months	4 years - 11 months	1-5/8%
4 years - 11 months	5 years - 4 months	1-3/4%
5 years - 4 months	5 years - 10 months	1-7/8%
5 years - 10 months	6 years - 5 months	2%
6 years - 5 months	7 years - 2 months	2-1/8%
7 years - 2 months	8 years - 3 months	2-1/4%
8 years - 3 months	9 years - 6 months	2-3/8%
9 years - 6 months	11 years - 2 months	2-1/2%
11 years - 2 months	13 years - 2 months	2-5/8%
13 years - 2 months	15 years - 8 months	2-3/4%
15 years - 8 months	19 years - 0 months	2-7/8%
19 years - 0 months	23 years - 1 month	3%
23 years - 1 month	27 years - 11 months	3-1/8%
27 years - 11 months	30 years - 1 day	3-1/4%

Note: The above interest rates do not include the one-eighth (1/8%) of one-percentage point for transaction costs required by Section 106 of P.L.99-662.

Water Supply Interest Rates for Fiscal Year 2015

The Water Supply Act of 1958 (PL 85-500) established that the Federal government may cooperate with non-Federal interests in their water supply development efforts. This Act established a repayment period of 50 years and a repayment interest rate equal to the nominal interest rate of outstanding Treasury securities of suitable periods to maturity. Section 932 of the Water Resources Development Act of 1986 (PL99-662) amended the repayment period to 30 years and the interest rate to the yield rate, plus a premium of one-eight of one percentage point for transactions costs.

I. Water Supply Interest Rates based on PL 99-662 – 3.500% (3.375% + 1/8%)

This interest is relevant for a 30-year repayment period as established in Section 932 of PL 99-662. This rate is used for agreements for storage not “grandfathered” (see following section III), for new storage reallocated to M&I water supply, for surplus water agreements, and for new projects. Repayment amounts must be readjusted every five years using the then current interest rate. For repayment periods other than 30-years see Section II, which follows below.

Water Supply Interest Rates for Fiscal Year 2015

The following table shows an historical series since 1986 for this interest rate.

FISCAL YEAR	INTEREST RATE
1987	7.625%
1988	10.000%
1989	9.250%
1990	8.250%
1991	9.125%
1992	8.125%
1993	7.500%
1994	6.125%
1995	7.750%
1996	6.750%
1997	7.125%
1998	6.750%
1999	5.375%
2000	6.125%
2001	5.875%
2002	5.625%
2003	5.125%
2004	5.500%
2005	5.125%
2006	4.625%
2007	4.875%
2008	4.875%
2009	4.625%
2010	4.125%
2011	4.250%
2012	4.125%
2013	2.875%
2014	3.125%
2015	**3.500%**

Note: The authorized one-eight of one percentage point for transactions costs is included in the rates in the values shown in this table.

II. Water Supply Interest Rates – for Repayment Periods other than 30 Years

For repayment periods less than 30 years interest rates are the same as specified under Section 106 of PL 99-662, and shown in the table on page 4 of Enclosure 2. The rate is used for agreements for storage not "grandfathered" (see following Section III), for new storage reallocated to M & I water supply, for surplus water agreements, and for new projects. Repayment amounts must be readjusted every five years using the then current interest rate.

III. Water Supply Interest Rate based on PL 85-500 – 4.934%

These interest rates are determined by the Department of the Treasury in accordance with provisions of the Water Supply Act of 1958, Section 301 (b). They are based on the nominal interest rate – as opposed to the yield – of Treasury securities with 15 or more years to redemption. Although the Water Supply Act was amended for Corps projects by PL 99-662, this interest rate remains relevant for the Bureau of Reclamation projects and some "grandfathered" Corps projects, and thus Treasury continues to report it.

Authorized water supply storage space in projects completed or under construction prior to enactment of PL 99-662 (17 November 1986) are to utilize the rate as established in the 1958 Water Supply Act and are thus "grandfathered." This rate is set at the time construction of the project was initiated. For FY 15 this rate is **4.934%**. While this "grandfathered" rate has no applicability for Corps projects after 1986, the following table shows the historic series.

FISCAL YEAR	INTEREST RATE	FISCAL YEAR	INTEREST RATE	FISCAL YEAR	INTEREST RATE
1959	2.670%	1980	7.250%	2000	8.542%
1960	2.699%	1981	8.605%	2001	8.469%
1961	2.632%	1982	9.352%	2002	8.315%
1962	2.742%	1983	10.051%	2003	8.270%
1963	2.936%	1984	10.403%	2004	8.209%
1964	3.046%	1985	10.898%	2005	8.077%
1965	3.137%	1986	11.070%	2006	7.892%
1966	3.222%	1987	10.693%	2007	7.652%
1967	3.225%	1988	10.371%	2008	7.457%
1968	3.253%	1989	10.250%	2009	7.095%
1969	3.256%	1990	10.075%	2010	6.568%
1970	3.342%	1991	9.920%	2011	6.081%
1971	3.463%	1992	9.737%	2012	5.769%
1972	3.502%	1993	9.503%	2013	5.357%
1973	3.649%	1994	9.319%	2014	5.101%
1974	4.012%	1995	9.226%	**2015**	**4.934%**
1975	4.371%	1996	9.134%		
1976	5.116%	1997	9.012%		
1977	5.683%	1998	8.874%		
1978	6.063%	1999	8.703%		
1979	6.595%				

Hydropower Interest Rate for Fiscal Year 2015

Rate applicable to interest during construction, investment cost repayment, and capitalized O&M costs – 3.375%

This rate is determined by the Department of the Treasury under Secretarial Order RA 6120.2 Paragraph 11 (c) of the Secretary of Energy and Departmental Manual 730 DM 3, superseding Secretarial Order 2929 of the Secretary of the Interior. This rate shown has been adjusted to the nearest 1/8 of 1%.

The table below contains a historical series for the hydropower interest rate.

FISCAL YEAR	INTEREST RATE	FISCAL YEAR	INTEREST RATE
1973	5.500%	2000	5.750%
1974	6.625%	2001	6.250%
1975	6.125%	2002	5.625%
1976	6.625%	2003	5.500%
1977	7.000%	2004	4.875%
1978	7.000%	2005	5.125%
1979	7.500%	2006	4.625%
1980	8.000%	2007	4.875%
1981	8.500%	2008	4.875%
1982	9.000%	2009	4.500%
1983	9.500%	2010	4.000%
1984	10.750%	2011	4.125%
1985	12.375%	2012	4.000%
1986	11.375%	2013	2.750%
1987	8.875%	2014	3.000%
1988	8.500%	**2015**	**3.375%**
1989	9.250%		
1990	8.875%		
1991	8.750%		
1992	8.500%		
1993	7.875%		
1994	7.125%		
1995	7.125%		
1996	7.625%		
1997	6.875%		
1998	6.875%		
1999	6.000%		

Delinquent Payment Collection Rate
Article XVI, ER 1165-2-131

Background - Paragraph a, Article XVI of ER 1165-2-131 explains the procedures used to calculate the interest rate for delinquent payment collection, per the Water Resources Development Act of 1986, Section 912 (b) [42 USC 1962d5b note]. Review of this article indicated that the explanation of paragraph a, is not adequately clear for consistent determination of the rate. In addition, the paragraph suggests that the Secretary of the Treasury should determine the interest rate. After reviewing the article, the Department of Treasury has developed the following procedure for the calculation of interest rates.

Procedure - The interest rate used in the collection of delinquent payment under this Article will be equal to the equivalent coupon-issue yield for 13-week Treasury bills in the month immediately preceding the date that the payment became delinquent or auctioned immediately prior to the beginning of each additional three-month period if the delinquency exceeds three months. District offices may obtain the equivalent coupon-issue yield by the Office of Public Debt Accounting, Bureau of the Public Debt at (304) 480-5151. The rate obtained from this office will then be multiplied by 1.5 to determine the interest rate used for repayment of the delinquency. Questions concerning this procedure can be addressed to CECW-P staff as identified in the cover memo.

Appendix F

USFWS BO and Appendices
NMFS BO and EFH Letters

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

August 6, 2015

Mr. Scott C. McLendon
Chief, Regulatory Division
Wilmington District, Corps of Engineers
69 Darlington Avenue
Wilmington, NC 28403-1343

Subject: Town of Ocean Isle Beach: Terminal Groin
Action ID No. SAW-2011-01241
FWS Log Number 04EN2000-2015-F-0201

Dear Mr. McLendon:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed terminal groin located in the Town of Ocean Isle, Brunswick County, NC, and its effects on piping plover (*Charadrius melodus melodus*), red knot (*Calidris canutus rufa*), seabeach amaranth (*Amaranthus pumilus*), West Indian manatee (*Trichechus manatus*), and the green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), Kemp's ridley sea turtle (*Lepidochelys kempi*), hawksbill sea turtle (*Eretmochelys imbricata*), and the Northwest Atlantic loggerhead sea turtle population (*Caretta caretta*) in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.). Your January 21, 2015 request for formal consultation was received on January 26, 2015.

This biological opinion is based on information provided in the January 2015 biological assessment (BA), the January 2015 Draft Environmental Impact Statement (DEIS) for the Town of Ocean Isle, the January 23, 2015 and September 21, 2012 public notices, the March 5, 2013 Project Review Team meeting, field investigations, and other sources of information. A complete administrative record of this consultation is on file at the Service's Raleigh Field Office. The Service has assigned Log number 04EN2000-2015-F-0201 to this consultation.

The Service concurs with the U.S. Army Corps of Engineers (Corps) determination of not likely to adversely affect (NLAA) for the hawksbill sea turtle and West Indian manatee (**Table 1**). Concurrence for the hawksbill sea turtle determination is based upon data that have documented no nests of that species in North Carolina. Concurrence for the West Indian manatee determination is based upon the timing of the project and the proposed conservation measures.

Table 1. Species and Critical Habitat Evaluated for Effects from the Proposed Action but not discussed further in this Biological Opinion.

SPECIES OR CRITICAL HABITAT	PRESENT IN ACTION AREA	PRESENT IN ACTION AREA BUT "NOT LIKELY TO ADVERSELY AFFECT"
West Indian manatee	Possible	Yes
Hawksbill Sea Turtle	Not documented	Yes

The Service appreciates the cooperation of the Corps during this consultation. We would like to continue working with you and your staff regarding this project. Please note that issuance of the BO does not limit the Service's ability to provide comments on the Final EIS or any future public notices concerning this project. For further coordination please contact Kathy Matthews at (919) 856-4520, ext. 27. In future correspondence concerning the project, please reference FWS Log No. 04EN2000-2015-F-0201.

Sincerely,

Acting Tom Augspurger

Pete Benjamin
Field Supervisor

cc: USFWS, Jacksonville, FL (Ann Marie Lauritsen) (via email)
USFWS, Hadley, MA (Anne Hecht) (via email)
USFWS, Pleasantville, NJ (Wendy Walsh) (via email)
NMFS, Pivers Island (via email)
NMFS, St. Peterburg, FL
NCDCM, Morehead City, NC
NCWRC, Washington, NC
Town of Ocean Isle Beach

BIOLOGICAL OPINION

Town of Ocean Isle Beach

Shoreline Management Project

August 6, 2015

Corps Action ID No. SAW-2011-01241

USFWS Log No. 04EN2000-2015-F-0201

Table of Contents

Acronyms

Act	**Endangered Species Act**
BA	**Biological Assessment**
BO	**Biological Opinion**
CAFF	**Council Conservation of Arctic Flora and Fauna**
CBRA	**Coastal Barrier Resources Act**
CFR	**Code of Federal Regulations**
CH	**Critical Habitat**
CITES	**Convention on International Trade in Endangered Species of Wild Fauna and Flora**
Corps	**U.S. Army Corps of Engineers**
COSEWIC	**Committee on the Status of Endangered Wildlife in Canada**
CSDR	**Coastal Storm Damage Reduction**
DOI	**U.S. Department of the Interior**
DTRU	**Dry Tortugas Recovery Unit**
F	**Fahrenheit**
FAC	**Florida Administrative Code**
FDEP	**Florida Department of Environmental Protection**
FEMA	**Federal Emergency Management Agency**
FR	**Federal Register**
GCRU	**Greater Caribbean Recovery Unit**
HCP	**Habitat Conservation Plan**
IPCC	**Intergovernmental Panel on Climate Change**
ITP	**Incidental Take Permit**
LF	**Linear Feet**
MHW	**Mean High Water**
MHWL	**Mean High Water Line**
MLLW	**Mean Low Low Water**
MLW	**Mean Low Water**
mtDNA	**Mitochondrial Deoxyribonucleic Acid**

NCWRC	**North Carolina Wildlife Resources Commission**
NGMRU	**Northern Gulf of Mexico Recovery Unit**
NMFS	**National Marine Fisheries Service**
NOAA	**National Oceanic and Atmospheric Administration**
NRU	**Northern Recovery Unit**
NWR	**National Wildlife Refuge**
PBF	**Physical and Biological Feature**
PCE	**Primary Constituent Element**
PFRU	**Peninsular Florida Recovery Unit**
SAJ	**South Atlantic Jacksonville**
SAM	**South Atlantic Mobile**
Service	**U.S. Fish and Wildlife Service**
SF	**Square Feet**
SNBS	**Statewide Nesting Beach Survey**
TED	**Turtle Excluder Device**
TEWG	**Turtle Expert Working Group**
U.S.C.	**United States Code**
U.S.	**United States**
USEPA	**United States Environmental Protection Agency**

CONSULTATION HISTORY

September 21, 2012 – The Corps issued a Notice of Intent (NOI) to prepare a Draft Environmental Impact Statement (DEIS) for the project. A Public Notice containing similar information was released by the Corps on the same date.

October 3, 2012 – A public scoping meeting was held for the project. The Service was unable to attend.

October 16, 2012 – The Service provided written scoping comments to the Corps.

March 5, 2013 – The Service attended a Project Review Team (PRT) meeting for the project.

January 21, 2015 – The Corps requested initiation of formal consultation for the project.

January 23, 2015 – The Corps issued a public notice and the DEIS for the project. The public notice comment period for the DEIS ended on March 16, 2015.

February 12, 2015 – The Service initiated formal consultation by letter to the Corps. The date for the biological opinion was set as June 10, 2015.

March 12, 2015 – The Service provided comments to the Corps on the DEIS.

April 21, 2015 – Due to the potential for new information to be provided by the applicant in response to comments on the DEIS, the Service emailed the Corps about the potential to extend the consultation period for 60 days.

April 27, 2015 – The Service requested a 60-day extension of the consultation period in accordance with 50 CFR §402.25(e) (to August 9, 2015).

July 10, 2015 – The Service provided the draft Reasonable and Prudent Measures and Terms and Conditions to the Corps.

July 16, 2015 – The Service discussed the draft Terms and Conditions with the Applicant's consultant by phone.

July 17, 2015 – The Service discussed the duration of the project construction (in months) with the Applicant's consultant by phone.

July 18, 2015 – By email, the Corps requested changes to the language of the Reasonable and Prudent Measures and Terms and Conditions.

July 20, 2015 – The applicant's consultant provided information by email concerning the duration of the initial project construction.

July 20, 2015 – By email, the Service provided revised language for the Reasonable and Prudent Measures and Terms and Conditions to the Corps.

July 21, 2015 – By email, the Corps agreed to the revised language for the Reasonable and Prudent Measures and Terms and Conditions.

BIOLOGICAL OPINION

I. INTRODUCTION

A biological opinion (BO) is the document that states the opinion of the U.S. Fish and Wildlife Service (Service) as to whether a federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. This biological opinion addresses piping plover (*Charadrius melodus melodus*), red knot (*Calidris canutus rufa*), seabeach amaranth (*Amaranthus pumilus*), and the loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), and Kemp's ridley sea turtles (*Lepidochelys kempii*), and designated loggerhead critical habitat. The BO evaluates the effects of the proposed action, interrelated and interdependent actions, and cumulative effects relative to the status of the species and the status of the critical habitat to arrive at a Service opinion that the proposed action is or isn't likely to jeopardize species or adversely modify critical habitat. *Jeopardize the continued existence of* means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. On May 9, 2014, the Service and the National Marine Fisheries Service (NMFS) proposed to define *destruction or adverse modification of designated critical habitat* as a direct or indirect alteration that appreciably diminishes the conservation value of critical habitat for listed species. Such alterations may include, but are not limited to, effects that preclude or significantly delay the development of the physical or biological features that support the life-history needs of the species for recovery. The Service plans to finalize the definition of *destruction or adverse modification of designated critical habitat* in the summer of 2015.

II. EXECUTIVE SUMMARY

The purpose of the proposed project is to alleviate chronic erosion on the eastern portion of Ocean Isle Beach to preserve the integrity of its infrastructure, provide protection to existing development, and ensure the continued use of the oceanfront beach along easternmost 3,500 feet of its oceanfront shoreline. The proposed project is the preferred alternative in the January 2015 Draft Environmental Impact Statement (DEIS) (Alternative 5). The project includes the construction of a single, 1,050 linear-foot (lf) terminal groin (300 lf landward, and 750 lf waterward of mean high water or MHW), placement of a concurrent 3,214 lf sand fillet, and the periodic placement of sand in the fillet from either scheduled federal disposal events and/or from locally-sponsored beach nourishment and disposal projects.

The Draft Environmental Impact Statement (DEIS) describes the Action Area to include the shorelines of Ocean Isle Beach and Holden Beach and the adjacent Atlantic Ocean and Shallotte

Inlet, Brunswick County, North Carolina. The Action Area includes 4,413 acres and approximately 24,500 lf of beach and inlet shoreline on Ocean Isle Beach and Holden Beach, from east of Concord Street on Ocean Isle Beach to an area near Sea Gull Street in Holden Beach. Federally-listed species under the purview of the Service occurring in the Action Area include the seabeach amaranth, piping plover, red knot, loggerhead sea turtle, green sea turtle, leatherback sea turtle, and Kemp's ridley sea turtle. The Action Area includes piping plover Critical Habitat Unit NC-17 (Shallotte Inlet – Brunswick County) and loggerhead terrestrial Critical Habitat Unit LOGG-T-NC-08 (Holden Beach).

The proposed action has the potential to adversely affect piping plover and piping plover critical habitat, red knot, seabeach amaranth, nesting female sea turtles, sea turtle nests, hatchlings, and loggerhead terrestrial critical habitat within the proposed Action Area.

The Service anticipates that directly and indirectly an unspecified amount of nesting female sea turtles, sea turtle nests, and sea turtle hatchlings along 24,500 lf of sea turtle nesting beach habitat could be taken as a result of this proposed action. Take is expected to be in the form of: (1) Destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey and nest mark and avoidance program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey and nest mark and avoidance program is not required to be in place within the boundaries of the proposed project; (3) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (4) misdirection of nesting sea turtles or hatchling turtles on beaches within the boundaries of the proposed project or beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of increased sand accretion due to the presence of the groin or jetty; (5) behavior modification of nesting females due to escarpment formation, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; (6) destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Service; (7) behavior modification of nesting females or hatchlings due to the presence of the groin which may act as a barrier to movement or cause disorientation of turtles while on the nesting beach; (8) physical entrapment of hatchling sea turtles on the nesting beach due to the presence of the groin; behavior modification of nesting females if they dig above a buried portion of the structure, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas; and (9) obstructed or entrapped an unknown number of adult and hatchling sea turtles during ingress or egress at nesting sites.

The Service anticipates that directly and indirectly an unspecified amount of piping plovers and red knots along 24,500 lf of shoreline, all at some point, potentially usable by piping plovers and red knots, could be taken in the form of habitat loss as a result of this proposed action.

The construction of the groin and placement of sand in the Action Area could bury existing plants if work is conducted during the growing season. Sand placement at any time of year could also bury seeds to a depth that would prevent germination. Sand placement beaches could also have positive impacts on seabeach amaranth by creating additional habitat for the species.

After reviewing the current status of the nesting loggerhead sea turtle, green sea turtle, and leatherback sea turtle, the environmental baseline for the Action Area, the effects of the proposed dredging and sand placement activities, the proposed Conservation Measures, and the cumulative effects, it is the Service's biological opinion that the groin construction and sand placement activities, as proposed, are not likely to jeopardize the continued existence of the piping plover, red knot, seabeach amaranth, green sea turtle, leatherback sea turtle, Kemp's ridley sea turtle and the Northwest Atlantic Ocean Distinct Population Segment of the loggerhead sea turtle. It is the Service's biological opinion that the groin construction and sand placement activities, as proposed, are not likely to result in the destruction or adverse modification of designated critical habitat for the piping plover or nesting loggerhead sea turtles.

The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize take of loggerhead sea turtles, green sea turtles, leatherback sea turtles, Kemp's ridley sea turtles, piping plovers, red knots, and seabeach amaranth. Unless specifically addressed below, these RPMs are applicable for the construction of the terminal groin and for any maintenance activities for the life of the permit. If the Applicant is unable to comply with the RPMs and Terms and Conditions, the Corps as the regulatory authority may inform the Service why the RPM or Term and Condition is not reasonable and prudent for the specific project or activity and request exception under the biological opinion.

<u>RPMs – All Species</u>

1. All derelict material or other debris must be removed from the beach prior to any construction.

2. Conservation Measures included in the permit application/project plans must be implemented in the proposed project. If a RPM and Term and Condition address the same requirement, the requirements of the RPM and Term and Condition take precedent over the Conservation Measure. This includes the timing of the proposed project to avoid the sea turtle nesting season, to reduce the possibility of sea turtle nest burial, crushing of eggs, or nest excavation.

3. Predator-proof trash receptacles must be installed and maintained at all beach access points used for the initial project construction and all maintenance events, to minimize

the potential for attracting predators of sea turtles, piping plovers, and red knots.

4. A meeting between representatives of the Applicant's contractor, Corps, Service, North Carolina Wildlife Resources Commission (NCWRC), the permitted sea turtle surveyor, bird and other species surveyors, as appropriate, must be held prior to the commencement of construction of the terminal groin.

5. In the event the terminal groin structure begins to disintegrate, all debris and structural material must be removed.

6. The Applicant or Corps must submit all reports produced pursuant to the Inlet Management Plan (referenced in the revisions to North Carolina General Statute 113A-115.1(e)(5)) to the Service's Raleigh Field Office, within 30 days of completion of each report.

7. The groin must be removed or modified if it is determined to not be effective as determined pursuant to the Inlet Management Plan listed above, or if it is determined to be causing a significant adverse impact to the beach and dune system.

8. During construction of the terminal groin, and for the life of the permit, all sand placement activities to maintain the sand fillet must be conducted within the winter work window (November 16 to April 30), unless necessitated by an emergency condition and allowed after consultation with the Service.

9. The pipeline placement must be coordinated with the Corps, the Raleigh Field Office, and the NCWRC.

<u>RPMs – Loggerhead, Green, Leatherback, and Kemp's Ridley Sea Turtle</u>

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of loggerhead, green, Kemp's ridley, and leatherback sea turtles:

1. Beach compatible sand suitable for sea turtle nesting, successful incubation, and hatchling emergence must be used on the project site for initial groin construction and all maintenance events.

2. No construction shall be conducted during the nesting season and hatching season from May 1 through November 15.

3. No permanent exterior lighting will be installed in association with this construction project, unless required by the U.S. Coast Guard. Temporary lighting will be allowed if safety lighting is required at any excavated trenches that must remain on the beach at night.

4. If the construction of the groin will be conducted during the period from April 15 to April 30, daily early morning surveys for early nesting sea turtles must be conducted. If the construction project will be conducted during the period from November 16 through November 30, surveys for late nesting sea turtles must be conducted. If nests are laid in the area of construction, the nests must be marked and avoided. Nesting surveys and nest marking must be initiated 65 days prior to construction activities or by April 15, whichever is later.

5. Visual surveys for escarpments along the Action Area must be made following completion of the terminal groin and any sand maintenance events, and also prior to May 1 for two subsequent years (after sand is placed on the beach). Escarpment formation must be monitored and leveling must be conducted if needed to reduce the likelihood of impacting nesting and hatchling sea turtles.

6. Staging areas for earth-moving equipment must be located off the beach during the early (April 15 through April 30) and late (November 16 through November 30) portions of the nesting season. Nighttime storage of earth-moving equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. All excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day.

7. Sand compaction must be monitored in the area of sand placement immediately after completion of the project, after any future sand maintenance events, and also prior to May 1 for two subsequent years after sand is placed on the beach.

8. Daily sea turtle nesting surveys must be conducted by the Applicant or Corps for three nesting seasons following construction of the groin or sand maintenance events; if the groin remains on the beach. All nests from a point 3,200 feet west (updrift) of the groin (at approximately Highpoint Street) to a point 2,000 feet east (downdrift) of the groin must be marked for three (3) years post-construction. These nests must be monitored daily until the end of incubation to determine whether those nests are eroded and whether the groin is a potential barrier to hatchlings moving off the beach and through the surf zone. If the groin is found to be an obstruction, Corps will notify NCWRC and the Service immediately for remedial action.

9. A report describing the fate of the nests and hatchlings and any actions taken, must be submitted to the Service following completion of the proposed work for each year when an activity has occurred (such as sand placement).

10. A post-construction survey of all artificial lighting visible from the adjacent beach (1,000 lf on either side of the groin) must be completed by the Applicant or Corps to determine if sand accretion caused by the groin created an increased impact due to artificial lighting within the vicinity of the groin structures.

RPMs – Piping Plover and Red Knot

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of piping plovers and red knots:

1. All personnel involved in the construction or sand placement process along the beach shall be trained to recognize the presence of piping plovers and red knots prior to initiation of work on the beach. Before start of work each morning, a visual survey must be conducted along the ingress routes and in the area of work for that day, to determine if piping plovers or red knots are present.

2. A bird monitoring plan must be developed to monitor piping plover, red knot, waterbirds, colonial waterbirds and other shorebirds in the Shallotte Inlet area during and after construction. Monitoring must be conducted for a minimum of three (3) full years past the completion of groin construction, or until the end of the shorebird nesting season (August 31) of the third year, whichever is later.

RPM – Seabeach Amaranth

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of seabeach amaranth:

1. Seabeach amaranth surveys must be conducted in the Action Area for a minimum of three years after completion of construction.

Terms and Conditions

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

Unless addressed specifically below, the terms and conditions are applicable for the construction of the terminal groin and for any maintenance activities for the life of the permit.

Terms and Conditions – All Species

1. All derelict coastal armoring geotextile material and other debris must be removed from the beach prior to any sand placement or construction to the maximum extent possible.

2. Conservation Measures included in the permit application/project plans must be implemented in the proposed project. If a RPM and Term and Condition address the same requirement, the requirements of the RPM and Term and Condition take precedent over the Conservation Measure. This includes the timing of the proposed project to avoid the sea turtle nesting season, to reduce the possibility of sea turtle nest burial, crushing of eggs, or nest excavation.

3. Predator-proof trash receptacles must be installed and maintained during construction at all beach access points used for the project construction and sand maintenance events, to minimize the potential for attracting predators of sea turtles, piping plovers, and red knots. All contractors conducting the work must provide predator-proof trash receptacles for the construction workers. All contractors and their employees must be briefed on the importance of not littering and keeping the Action Area free of trash and debris. See **Appendix A** for examples of suitable receptacles.

4. A meeting between representatives of the contractor, the Service, NCWRC, the permitted sea turtle surveyor, bird and other species surveyors, as appropriate, must be held prior to the commencement of construction of the terminal groin. At least 10 business days advance notice must be provided prior to conducting this meeting. The meeting will provide an opportunity for explanation and/or clarification of the required measures in the BO, as well as follow-up meetings during construction.

5. In the event the structure begins to disintegrate, all debris and structural material must be removed from the nesting beach area and deposited off-site immediately upon coordination with the Service. If removal of the structure is required during the period from May 1 to November 15, no work will be initiated without prior coordination with the Corps and the Service.

6. The Applicant or Corps must submit all reports produced pursuant to the Inlet Management Plan (referenced in the revisions to North Carolina General Statute 113A-115.1(e)(5)) to the Service's Raleigh Field Office, within 30 days of completion of each report.

7. The groin must be removed or modified if it is determined to not be effective as determined by the Inlet Management Plan referred to above, or if it is determined to be causing a significant adverse impact to the beach and dune system.

8. During construction of the terminal groin, and for the life of the permit, all sand placement activities to maintain the sand fillet must be conducted within the winter work window (November 16 to April 30), unless necessitated by an emergency condition and allowed after consultation with the Service.

9. The pipeline placement must be coordinated with the Corps, the Raleigh Field Office, and the NCWRC.

<u>Terms and Conditions – Loggerhead, Green, Kemp's ridley, and Leatherback Sea Turtle</u>

1. Beach compatible fill must be placed on the beach or in any associated dune system. Beach compatible fill must be sand that is similar to a native beach in the vicinity of the site that has not been affected by prior sand placement activity. Beach compatible fill must be sand solely of natural sediment and shell material, containing no construction debris, toxic material, large amounts of rock, or other foreign matter. The beach compatible fill must be similar in both color and grain size distribution (sand grain frequency, mean and median grain size and sorting coefficient) to the native material in the Action Area. Beach compatible fill is material that maintains the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system. In general, fill material that meets the requirements of the North Carolina Technical Standards for Beach Fill (15A NCAC 07H .0312) is considered compatible.

2. During the nesting season (May 1 through November 15), no construction will be allowed on the beach, and no equipment may be placed and/or stored on the beach.

3. No permanent exterior lighting will be installed in association with this construction project, unless required by the U.S. Coast Guard. Temporary lighting will be allowed if safety lighting is required at any excavated trenches that must remain on the beach at night.

4. If the construction of the groin will be conducted during the period from April 15 to April 30, daily early morning surveys for early nesting sea turtles must be conducted. If the construction project will be conducted during the period from November 16 through November 30, surveys for late nesting sea turtles must be conducted. If nests are laid in the area of construction, the nests must be marked and avoided. Nesting surveys and nest marking must be initiated 65 days prior to construction activities or by April 15, whichever is later.

5. Visual surveys for escarpments along the Action Area must be made immediately after completion of construction, after sand maintenance events, and within 30 days prior to May 1 for two subsequent years after any construction or sand placement event. Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet must be leveled and the beach profile must be reconfigured to minimize scarp formation by the dates listed above. Any escarpment removal must be reported by location. The Service must be contacted immediately if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service or NCWRC will provide a brief written authorization within 30 days that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken must be submitted to the Service's Raleigh Field Office.

6. Staging areas for earth-moving equipment must be located off the beach during the early (April 15 through April 30) and late (November 16 through November 30) portions of the nesting season. Nighttime storage of earth-moving equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. All excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day. During any periods when excavated trenches must remain on the beach at night, nighttime sea turtle monitoring by the sea turtle permit holder will be required in the project area in order to further reduce possible impacts to nesting and hatchling sea turtles. Nighttime monitors will record data on false crawls, successful nesting, and any additional activities of nesting or hatchling sea turtles in the project area.

7. Sand compaction must be monitored in the area of sand placement immediately after completion of the construction, after any sand maintenance event, and also prior to May 1 for two subsequent years after any construction or sand placement event.

Out-year compaction monitoring and remediation are not required if the placed material no longer remains on the dry beach.

a. Within 7 days of completion of sand placement and prior to any tilling, a field meeting shall be held with the Service, NCWRC, and the Corps to inspect the Action Area for compaction, and determine whether tilling is needed.
b. If tilling is needed, the area must be tilled to a depth of 36 inches.
c. All tilling activity shall be completed prior to May 1.
d. Tilling must occur landward of the wrack line and avoid all vegetated areas that are 3square foot (sf) or greater, with a 3 sf buffer around the vegetated areas.
e. If tilling occurs during shorebird nesting season (after April 1), shorebird surveys are required prior to tilling per the Migratory Bird Treaty Act.
f. A report on the results of compaction monitoring will be submitted to the Raleigh Field Office and NCWRC prior to any tilling actions being taken. An annual summary of compaction assessments and the actions taken will be submitted to the Service, as required in REPORTING REQUIREMENTS, below.
g. This condition will be evaluated annually and may be modified if necessary to address sand compaction problems identified during the previous year.

8. Daily sea turtle nesting surveys must be conducted by the Applicant or Corps for three (3) full nesting seasons following construction if the groin structure remains in place. All nests from a point 3,200 feet west (updrift) of the groin (at approximately High Point Street) to a point 2,000 feet east (downdrift) of the groin must be marked for three (3) years post-construction. The survey area must be divided into three segments: Updrift Zone, Project Zone, and Downdrift Zone. The parameters listed in **Appendix B** shall be recorded for each crawl encountered on a daily survey. In addition, any obstructions (natural or man-made) encountered by the turtle and the turtle's response to that obstruction must be reported. These nests must be monitored daily till the end of hatching to determine whether those nests are eroded and whether the groin is a potential barrier to hatchlings moving off the beach and through the surf zone. This information will be provided to the Raleigh Field Office pursuant to the REPORTING REQUIREMENTS section, below, and will be used to periodically assess the cumulative effects of these projects on sea turtle nesting and hatchling production and monitor suitability for nesting. The Corps will notify the NCWRC and the Service immediately for remedial action.

9. A report describing the fate of sea turtle nests and hatchlings and any actions taken, must be submitted to the Raleigh Field Office following completion of the proposed work for each year when an activity has occurred (e.g. sand placement or groin construction). Please see REPORTING REQUIREMENTS below, for more information.

10. A post construction survey(s) of all artificial lighting visible from the adjacent beach (100 feet on either side of the groin must be completed by the Applicant or Corps. Two surveys must be conducted of all lighting visible from the construction area by the Applicant or the Corps, using standard techniques for such a survey (**Appendix C**), in the year following construction. The first survey must be conducted between May 1 and May 15 and a brief summary provided to the Raleigh Field Office. The second survey must be conducted between July 15 and August 1. A summary report of the surveys, (include the following information: methodology of the survey, a map showing the position of the lights visible from the beach, a description of each light source visible from the beach, recommendations for remediation, and any actions taken), must be submitted to the Raleigh Field Office within 3 months after the last survey is conducted. After the annual report is completed, a meeting must be set up with the Applicant, county or municipality, NCWRC, Corps, and the Service to discuss the survey report, as well as any documented sea turtle disorientations in or adjacent to the project area.

<u>Terms and Conditions – Piping Plover and Red Knot</u>

1. All personnel involved in the construction or sand placement process along the beach shall be trained to recognize the presence of piping plovers and red knots prior to initiation of work on the beach. Before start of work each morning, a visual survey must be conducted along the ingress route and in the area of work for that day, to determine if piping plovers or red knots are present. If plovers or red knots are present in the work area, careful movement of equipment in the early morning hours should allow those individuals to move out of the area. If piping plovers or red knots are observed, the observer shall make a note on the Quality Assurance form for that day, and submit the information to the Corps and the Service's Raleigh Field Office the following day.

2. A bird monitoring plan must be developed to monitor piping plover, red knot, waterbirds, colonial waterbirds and other shorebirds during and after construction. Monitoring must be conducted for a minimum of three (3) full years past the completion of groin construction, or until the end of the shorebird nesting season (August 31) of the third year after construction, whichever is later. Post-construction monitoring may only be ceased after the review of at least three years' worth of data and approval by the Corps, Service, NCDCM, and NCWRC.
    a. The bird monitoring plan, including methods and a figure showing the proposed locations and extent of monitoring, must be submitted for review and approval to the Corps, Service, NCDCM, and NCWRC, at least 60 days prior to the anticipated start of construction.

b. During construction, bird monitoring must be conducted weekly. For at least three years after construction is completed, bimonthly (twice-monthly) bird surveys shall be conducted in all intertidal and shoreline areas from a point 3,200 lf west (updrift) of the groin (at approximately Highpoint Street) to a point just west of Skimmer Court on Holden Beach. All intertidal and supratidal unvegetated areas of the oceanfront, inlet shoulders, and sandy shoreline along the AIWW (in the vicinity of Shallotte Inlet and piping plover critical habitat unit NC-17) must be included. Field observations must be conducted during daylight hours, and primarily during high tide.

c. Shorebird identification, especially when in non-breeding plumage, can be difficult. The person(s) conducting the survey must demonstrate the qualifications and ability to identify shorebird species and be able to provide the information listed below. The bird monitoring plan should include the collection and reporting of the following:

   i. Date, location, time of day, weather, and tide cycle when survey was conducted;
   ii. Latitude and longitude of observed piping plover and red knot locations (decimal degrees preferred);
   iii. Any color bands observed on piping plovers or red knots or other birds;
   iv. Behavior (e.g., foraging, roosting, preening, bathing, flying, aggression, walking, courtship, copulation);
   v. Landscape features(s) where birds are located (e.g., inlet spit, tidal creeks, shoals, lagoon shoreline);
   vi. Habitat features(s) used by birds when observed (e.g., intertidal, fresh wrack, old wrack, dune, mid-beach, vegetation);
   vii. Substrata used by birds (e.g., sand, mud/sand, mud, algal mat); and
   viii. The amount and type of recreational use (e.g., people, dogs on or off leash, vehicles, kite-boarders).

d. All monitoring information shall be provided in standardized form on an Excel spreadsheet. Monitoring results shall be submitted (datasheets, maps, database) on standard electronic media (e.g., CD, DVD) to the Raleigh Field Office. Please see REPORTING REQUIREMENTS below, for more information.

<u>Terms and Conditions – Seabeach Amaranth</u>

1. Seabeach amaranth surveys must be conducted updrift and downdrift of the terminal groin in the Action Area, from a point 3,200 lf west of the groin (at approximately Highpoint Street) along Ocean Isle Beach to a point 2,000 lf east of the groin, for a minimum of three years after completion of groin construction. Surveys should be

conducted in August of each year. Habitat known to support this species, including the upper edges of the beach, lower foredunes, and overwash flats must be visually surveyed for the plant. Annual reports should include numbers of plants, latitude/longitude, and habitat type. Please see REPORTING REQUIREMENTS, below, for more information.

Reporting Requirements

An annual report detailing the monitoring and survey data collected during the preceding year (required in the above Terms and Conditions) and summarizing all piping plover, red knot, shorebird, seabeach amaranth, and sea turtle data must be provided to the Raleigh Field Office by January 31 of each year for review and comment. In addition, any information or data related to a conservation measure or recommendation that is implemented should be included in the annual report. The contact for these reporting requirements is:

Pete Benjamin, Supervisor
Raleigh Field Office
U.S. Fish and Wildlife Service
Post Office Box 33726
Raleigh, North Carolina 27636-3726
(919) 856-4520

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification must be made to the Service Law Enforcement Office below. Additional notification must be made to the Service Ecological Services Field Office identified above and to the NCWRC at (252) 241-7367. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

Tom Chisdock
U.S. Fish and Wildlife Service
160 Zillicoa St.
Asheville, NC 28801
828-258-2084

Reinitiation Notice

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

In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

For this biological opinion, the incidental take will be exceeded when the groin construction and nourishment of 24,500 lf of beach extends beyond the project's authorized boundaries. Incidental take of an undetermined number of young or eggs of sea turtles, piping plovers, red knots, and seabeach amaranth plants has been exempted from the prohibitions of section 9 by this opinion.

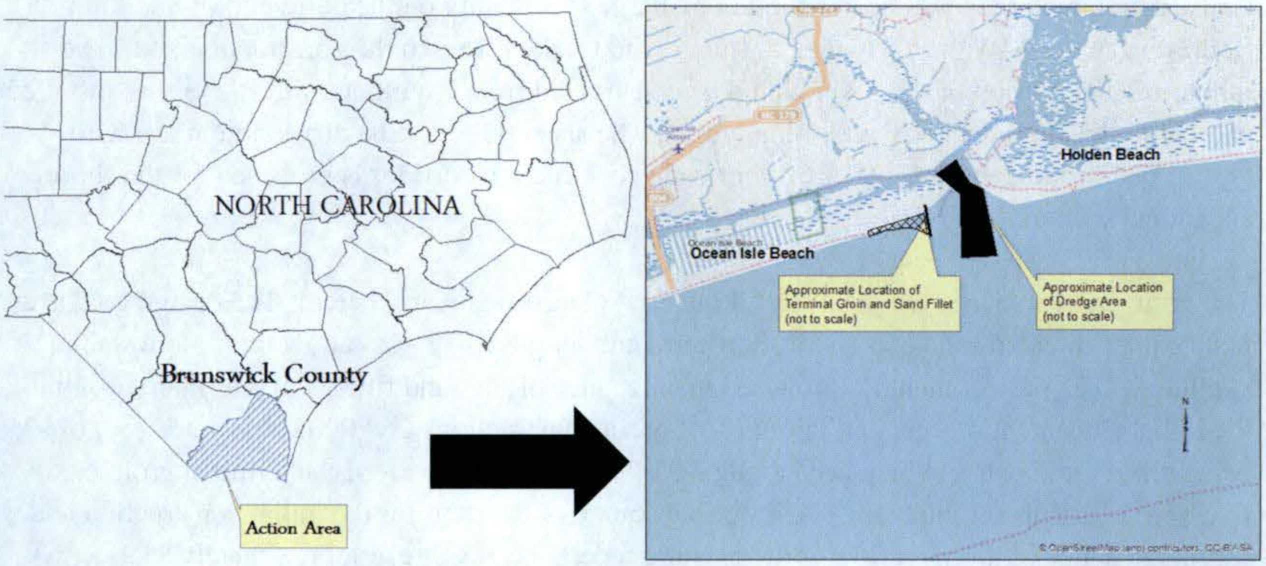
III. DESCRIPTION OF THE PROPOSED ACTION

A. Project Description

The purpose of the proposed project is to alleviate chronic erosion on the eastern portion of Ocean Isle Beach to preserve the integrity of its infrastructure, provide protection to existing development, and ensure the continued use of the oceanfront beach along easternmost 3,500 feet of its oceanfront shoreline. The proposed project is the preferred alternative in the January 2015 Draft Environmental Impact Statement (DEIS) (Alternative 5). The project includes the construction of a single, 1,050 lf terminal groin (300 lf landward, and 750 lf waterward of mean high water or MHW), placement of a concurrent 3,214 lf sand fillet, and the periodic placement of sand in the fillet from either scheduled federal disposal events and/or from locally-sponsored beach nourishment and disposal projects.

The DEIS describes the Action Area to include the shorelines of Ocean Isle Beach and Holden Beach and the adjacent Atlantic Ocean and Shallotte Inlet, Brunswick County, North Carolina (**Figure 1**). The Action Area includes 4,413 acres and approximately 24,500 lf of beach and inlet shoreline on Ocean Isle Beach and Holden Beach, from east of Concord Street on Ocean Isle Beach to an area near Sea Gull Street in Holden Beach. The Action Area for direct impacts includes those sections of Ocean Isle where terminal groin construction, sediment disposal, and earthen manipulation will occur – approximately 3,500 lf within the construction footprint and west of the groin (updrift). The Action Area for indirect impacts, however, is much larger. Because sea turtles and piping plovers are highly mobile species, animals influenced by direct project impacts may move great distances from the actual project site. The range of these movements produced by the project constitutes the Action Area for indirect impacts; for the purposes of this opinion it will be approximately 24,500 lf of beach and inlet shoreline on Ocean Isle Beach and Holden Beach for piping plovers, red knots, and sea turtles. The Action Area for seabeach amaranth is the area within the 3,500 lf proposed project footprint and the shoreline from the proposed groin to Shallotte Inlet (approximately 2,000 lf to the east or downdrift of the groin).

Figure 1. Action Area



Ocean Isle Beach was incorporated in 1959. Land ownership within the Action Area is both public and private, and land use encompasses recreational, commercial, and residential activities. Approximately 80% of uplands in Ocean Isle are developed, and the majority of the development is residential. The Action Area was relatively undeveloped until the 1970s and 1980's. Since then, it has become heavily developed with homes, shops, and recreational facilities. According to the Biological Assessment (BA), the permanent population of Ocean Isle is approximately 554, with a seasonal population of 25,000.

B. Project Design

The applicant proposes to construct a 750 lf terminal groin with a 300 lf shore anchorage system (1,050 lf total). The groin is proposed to be constructed of 7.5- to 12- ton stone rubble approximately 5 feet in diameter, while the anchorage system is proposed to be constructed using sheet piles. The rubblemound portion of the groin will cover approximately 52,500 square feet of area below MHW. The groin is proposed at a crest height of +4.9 feet NAVD, while the sheet piles are proposed to have a top elevation of +4.9 feet NAVD for a distance of about 130 feet between the landward end of the rubblemound section and the existing dune, and a top elevation of +4.5 feet NAVD for the remaining 170 feet. Excavation is needed for the landward 100 to 150 feet of the rubblemound portion of the structure in order to place the foundation stone or mattress at an elevation of -5.0 feet NAVD. From that point seaward, the foundation stone/mattress would be placed on grade.

Construction materials will be transported by barge to a facility on the north end of Shallotte Boulevard in the AIWW, off-loaded to trucks, and trucked from to the construction site. The rubble-mound portion of the groin would be constructed from a temporary trestle or pier installed parallel to the alignment of the terminal groin. The sheet piles will be driven into place with typical pile driving equipment. A 50-foot wide construction corridor is proposed for the shore anchorage section.

The groin will serve as a template for fill material placed westward thereof. The design goal is to reduce inlet-directed sand loss (both short-term and long-term) and to allow for a more stable condition. The project includes proposed maintenance of the sand fillet at 5-year intervals after the initial placement of sand and initiation of groin construction. 264,000 cubic yards (cy) of beach fill is anticipated to be placed along 3,214 lf of shoreline west of the terminal groin on a five-year nourishment interval. The proposed source of the sand for the initial construction and for maintenance of the sand fillet is the existing federal borrow area (approximately 83.1 acres) within Shallotte Inlet. Dredging is proposed with a cutterhead pipeline dredge.

According to the BA, the groin is designed as a leaky structure. The rubblemound portion of the groin would be constructed with loosely placed armor stone on top of a foundation mat or mattress. The loose nature of the armor stone was designed to facilitate the movement of littoral material through the structure while the relative low crest elevation would allow some sediment to pass over the structure during periods of high tide.

This BO addresses impacts to the piping plover (*Charadrius melodus*), red knot (*Calidris canutus rufa*), seabeach amaranth (*Amaranthus pumilus*), the leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles, and the Northwest Atlantic Ocean Distinct Population Segment of the loggerhead sea turtle (*Caretta caretta*), all Federally-listed species under the purview of the Service occurring in the Action Area. This BO also addresses critical habitat for piping plover and terrestrial critical habitat for loggerhead sea turtles. Whales, sturgeon, and sea turtles in the water are the jurisdiction of

NMFS. The Service and NMFS share Federal jurisdiction for sea turtles under the Act. The Service has responsibility for sea turtles on the nesting beach. NMFS has jurisdiction for sea turtles in the marine environment. Activities proposed in this formal consultation would involve only impacts to sea turtles in the terrestrial environment, which includes the following life stages: nesting sea turtles, nests and eggs, and hatchlings as they emerge from the nest and crawl to the sea.

C. Project Timing and Duration

The dredging of Shallotte Inlet and the beach nourishment on Ocean Isle Beach is proposed to be conducted between November15 and April 30. The initial groin construction and placement of sand is expected to take up to 4 ½ months. On approximately 5-year intervals, maintenance of the 3,214 lf sand fillet is anticipated to take approximately 10 weeks.

D. Conservation Measures

To reduce the potential impacts of the proposed project on Federally-listed species, the Applicant has proposed the following Conservation Measures:

- Dredging and beach nourishment are scheduled to occur between November 16th and April 30th.

- A hydraulic cutterhead dredge will be used to dredge material from the borrow area. DREDGEPAK or similar navigation and positioning software will be used to accurately track the dredge location.

- The contractor will be required to abide by defined construction corridors, approved access locations and staging areas, and permitted construction timeframes.

- A construction corridor varying in width from 100 feet to 200 feet will be established around the footprint of the structure.

- Multiple daily observations of the pump-out location will be made of the material being placed on the beach. If incompatible material is placed on the beach, the Corps and appropriate resource agencies will be contacted immediately to determine appropriate actions.

- The Town of Ocean Isle Beach, the Engineer, or their duly authorized representative will collect a representative sub-surface grab sediment sample from each 100-foot long section of the constructed beach to visually assess grain size, wet Munsell color, granular, gravel, and silt content. If deemed necessary by the Engineer, or his duly authorized representative, quantitative assessments of the sand will be conducted for grain size, wet Munsell color, and content of gravel, granular, and silt.

- Visual surveys of escarpments will be made along the beach fill area immediately after completion of construction. Escarpments in the newly placed beach fill that exceed 18 inches for greater than 100 feet shall be graded to match adjacent grades on the beach. Removal of any escarpments during the sea turtle hatching season (May 1 through November 15) shall be coordinated with the NCWRC, Service, and the Corps.

- Turbidity monitoring during construction will be managed by the contractor. The contractor will be responsible for notifying the construction engineer in the event that the turbidity levels exceed the State water quality standards.

- In order to minimize adverse impact on wintering piping plover, the pipeline alignment will be designed to avoid potential piping plover wintering habitat. The alignment will be coordinated with and approved by the Corps.

- In order to avoid adverse impacts associated with the transport of fill material to the disposal sites, the Town of Ocean Isle Beach will negotiate with the dredge contractor to monitor and assess the pipeline during construction, to avoid leaking of sediment from the pipeline couplings and other equipment. The Town, along with its Engineer, will coordinate with the dredgers to have in place a mechanism to cease dredge and fill activities in the event that a substantial leak is detected.

- The construction crew will be advised of the restrictions established under Section 9 of the ESA prior to construction.

IV. LOGGERHEAD, GREEN, LEATHERBACK, AND KEMP'S RIDLEY SEA TURTLES

A. Status of the Species/Critical Habitat

1) Species/Critical Habitat Description

Species/Critical Habitat Description – Loggerhead Sea Turtle

The loggerhead sea turtle, which occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans, was federally listed worldwide as a threatened species on July 28, 1978 (43 Federal Register (FR) 32800). On September 22, 2011, the loggerhead sea turtle's listing under the Act was revised from a single threatened species to nine distinct population segments (DPS) listed as either threatened or endangered. The nine DPSs and their statuses are:

Northwest Atlantic Ocean DPS – threatened
Northeast Atlantic Ocean – endangered
Mediterranean Sea DPS – endangered
South Atlantic Ocean DPS – threatened
North Pacific Ocean DPS – endangered
South Pacific Ocean DPS – endangered
North Indian Ocean DPS – endangered
Southwest Indian Ocean – threatened
Southeast Indo-Pacific Ocean DPS – threatened

The loggerhead sea turtle grows to an average weight of about 200 pounds and is characterized by a large head with blunt jaws. Adults and subadults have a reddish-brown carapace. Scales on the top of the head and top of the flippers are also reddish-brown with yellow on the borders. Hatchlings are a dull brown color (National Marine Fisheries Service (NMFS) 2009a). The loggerhead feeds on mollusks, crustaceans, fish, and other marine animals.

The loggerhead may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky places, and ship wrecks are often used as feeding areas. Within the Northwest Atlantic, the majority of nesting activity occurs from April through September, with a peak in June and July (Williams-Walls et al. 1983; Dodd 1988; Weishampel et al. 2006). Nesting occurs within the Northwest Atlantic along the coasts of North America, Central America, northern South America, the Antilles, Bahamas, and Bermuda, but is concentrated in the southeastern United

States and on the Yucatán Peninsula in Mexico on open beaches or along narrow bays having suitable sand (Sternberg 1981; Ehrhart 1989; Ehrhart et al. 2003; NMFS and Service 2008).

Designated critical habitat

On July 10, 2014, the Service designated portions North Carolina beaches as critical habitat for the Northwest Atlantic (NWA) population of loggerhead sea turtles. Holden Beach is located within Critical Habitat Unit LOGG-T-NC-08 (Oak Island, Brunswick County). From the Federal Register (FR) Notice (see http://www.regulations.gov/#!documentDetail;D=FWS-R4-ES-2012-0103-0001), this unit consists of 13.4 km (8.3 miles) of island shoreline along the Atlantic Ocean and extends from Lockwoods Folly Inlet to Shallotte Inlet. The island is separated from the mainland by the Atlantic Intracoastal Waterway, Elizabeth River, Montgomery Slough, Boone Channel, and salt marsh. The unit includes lands from the MHW line to the toe of the secondary dune or developed structures. Land in this unit is in private and other ownership (see Table 1). This unit was occupied at the time of listing and is currently occupied. This unit supports expansion of nesting from an adjacent unit (LOGG-T-NC-07) that has high-density nesting by loggerhead sea turtles in North Carolina.

In total, 1,189.9 kilometers (km) (739.3 miles) of loggerhead sea turtle nesting beaches are designated critical habitat in the States of North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. These beaches account for 48 percent of an estimated 2,464 km (1,531 miles) of coastal beach shoreline, and account for approximately 84 percent of the documented nesting (numbers of nests) within these six States. The designated critical habitat has been identified by the recovery unit in which they are located. Recovery units are management subunits of a listed entity that are geographically or otherwise identifiable and essential to the recovery of the listed entity. Within the United States, four terrestrial recovery units have been designated for the Northwest Atlantic population of the loggerhead sea turtle: the Northern Recovery Unit (NRU), Peninsular Florida Recovery Unit (PFRU), Dry Tortugas Recovery Unit (DTRU), and Northern Gulf of Mexico Recovery Unit (NGMRU). For the NRU, the Service has designated 393.7 km (244.7 miles) of Atlantic Ocean shoreline in North Carolina, South Carolina, and Georgia, encompassing approximately 86 percent of the documented nesting (numbers of nests) within the recovery unit.

Under the Act and its implementing regulations, the Service is required to identify the physical or biological features (PBFs) essential to the conservation of the loggerhead sea turtle in areas occupied at the time of listing, focusing on the features' primary constituent elements (PCEs). The Service determined that the following PBFs are essential for the loggerhead sea turtle:

(1) **PBF 1**—Sites For Breeding, Reproduction, or Rearing (or Development) of Offspring. To be successful, reproduction must occur when environmental conditions support adult activity (e.g., sufficient quality and quantity of food in the foraging area, suitable beach structure for digging, nearby inter-nesting habitat) (Georges et al. 1993). The environmental conditions of the nesting beach must favor embryonic development and survival (i.e., modest temperature fluctuation, low salinity, high humidity, well drained, well aerated) (Mortimer 1982; Mortimer 1990). Additionally, the hatchlings must emerge to onshore and offshore conditions that enhance their chances of survival (e.g., less than 100 percent depredation, appropriate offshore currents for dispersal) (Georges et al. 1993).

(2) **PBF 2** - Natural Coastal Processes or Activities That Mimic These Natural Processes. It is important that loggerhead nesting beaches are allowed to respond naturally to coastal dynamic processes of erosion and accretion or mimic these processes.

The Service considers PCEs to be those specific elements of the PBFs that provide for a species' life-history processes and are essential to the conservation of the species. Based on our current knowledge of the PBFs and habitat characteristics required to sustain the species' life-history processes, the terrestrial primary constituent elements specific to the Northwest Atlantic Ocean DPS of the loggerhead sea turtle are the extra-tidal or dry sandy beaches from the mean high-water line to the toe of the secondary dune, which are capable of supporting a high density of nests or serving as an expansion area for beaches with a high density of nests and that are well distributed within each State, or region within a State, and representative of total nesting, consisting of four components:

(1) **PCE 1**—Suitable nesting beach habitat that has (a) relatively unimpeded nearshore access from the ocean to the beach for nesting females and from the beach to the ocean for both post-nesting females and hatchlings and (b) is located above mean high water to avoid being inundated frequently by high tides.

(2) **PCE 2**—Sand that (a) allows for suitable nest construction, (b) is suitable for facilitating gas diffusion conducive to embryo development, and (c) is able to develop and maintain temperatures and a moisture content conducive to embryo development.

(3) **PCE 3**—Suitable nesting beach habitat with sufficient darkness to ensure nesting turtles are not deterred from emerging onto the beach and hatchlings and post-nesting females orient to the sea.

(4) **PCE 4**—Natural coastal processes or artificially created or maintained habitat mimicking natural conditions. This includes artificial habitat types that mimic the natural conditions

described in PCEs 1 to 3 above for beach access, nest site selection, nest construction, egg deposition and incubation, and hatchling emergence and movement to the sea.

This unit contains all of the PBFs and PCEs. The PBFs in this unit may require special management considerations or protections to ameliorate the threats of recreational use, predation, beach sand placement activities, in-water and shoreline alterations, climate change, beach erosion, artificial lighting, human-caused disasters, and response to disasters. The critical habitat in the project area has been relatively undisturbed since designation in 2014.

Species/Critical Habitat Description - Green Sea Turtle

The green sea turtle was federally listed on July 28, 1978 (43 FR 32800). Breeding populations of the green turtle in Florida and along the Pacific Coast of Mexico are listed as endangered; all other populations are listed as threatened. The green sea turtle has a worldwide distribution in tropical and subtropical waters.

The green sea turtle grows to a maximum size of about 4 feet and a weight of 440 pounds. It has a heart-shaped shell, small head, and single-clawed flippers. The carapace is smooth and colored gray, green, brown, and black. Hatchlings are black on top and white on the bottom (NMFS 2009b). Hatchling green turtles eat a variety of plants and animals, but adults feed almost exclusively on seagrasses and marine algae.

Major green turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica, and Surinam. Within the U.S., green turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and in larger numbers along the east coast of Florida, particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties (NMFS and Service 1991). Nests have been documented, in smaller numbers, north of these Counties, from Volusia through Nassau Counties in Florida, as well as in Georgia, South Carolina, North Carolina, and as far north as Delaware in 2011. Nests have been documented in smaller numbers south of Broward County in Miami-Dade. Nesting also has been documented along the Gulf coast of Florida from Escambia County through Franklin County in northwest Florida and from Pinellas County through Monroe County in southwest Florida (FWC/FWRI 2010b).
Green sea turtles are generally found in fairly shallow waters (except when migrating) inside reefs, bays, and inlets. The green turtle is attracted to lagoons and shoals with an abundance of marine grass and algae. Open beaches with a sloping platform and minimal disturbance are required for nesting. Critical habitat for the green sea turtle has been designated for the waters surrounding Culebra Island, Puerto Rico, and its outlying keys. There is no designated critical habitat in North Carolina.

Species/Critical Habitat Description - Leatherback Sea Turtle

The leatherback sea turtle was federally listed as an endangered species on June 2, 1970 (35 FR 8491). Leatherbacks have the widest distribution of the sea turtles with nonbreeding animals recorded as far north as the British Isles and the Maritime Provinces of Canada and as far south as Argentina and the Cape of Good Hope (Pritchard 1992). Foraging leatherback excursions have been documented into higher-latitude subpolar waters. They have evolved physiological and anatomical adaptations (Frair et al. 1972; Greer et al. 1973) that allow them to exploit waters far colder than any other sea turtle species would be capable of surviving.

The adult leatherback can reach 4 to 8 feet in length and weigh 500 to 2,000 pounds. The carapace is distinguished by a rubber-like texture, about 1.6 inches thick, made primarily of tough, oil-saturated connective tissue. Hatchlings are dorsally mostly black and are covered with tiny scales; the flippers are edged in white, and rows of white scales appear as stripes along the length of the back (NMFS 2009c). Jellyfish are the main staple of its diet, but it is also known to feed on sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed. This is the largest, deepest diving of all sea turtle species.

Leatherback turtle nesting grounds are distributed worldwide in the Atlantic, Pacific, and Indian Oceans on beaches in the tropics and subtropics. The Pacific Coast of Mexico historically supported the world's largest known concentration of nesting leatherbacks. The leatherback turtle regularly nests in the U.S. Caribbean in Puerto Rico and the U.S. Virgin Islands. Along the U.S. Atlantic coast, most nesting occurs in Florida (NMFS and Service 1992). Nesting has also been reported in Georgia, South Carolina, and North Carolina (Rabon et al. 2003) and in Texas (Shaver 2008). Adult females require sandy nesting beaches backed with vegetation and sloped sufficiently so the distance to dry sand is limited. Their preferred beaches have proximity to deep water and generally rough seas.

Marine and terrestrial critical habitat for the leatherback sea turtle has been designated at Sandy Point on the western end of the island of St. Croix, U.S. Virgin Islands (50 Code of Federal Regulations (CFR) 17.95). There is no designated critical habitat in North Carolina.

Species/Critical Habitat Description – Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle was federally listed as endangered on December 2, 1970 (35 FR 18320). The Kemp's ridley, along with the flatback sea turtle (*Natator depressus*), has the most geographically restricted distribution of any sea turtle species. The range of the Kemp's ridley includes the Gulf coasts of Mexico and the U.S., and the Atlantic coast of North America as far north as Nova Scotia and Newfoundland.

Adult Kemp's ridleys and olive ridleys are the smallest sea turtles in the world. The weight of an adult Kemp's ridley is generally between 70 to 108 pounds with a carapace measuring approximately 24 to 26 inches in length (Heppell et al. 2005). The carapace is almost as wide as it is long. The species' coloration changes significantly during development from the grey-black dorsum and plastron of hatchlings, a grey-black dorsum with a yellowish-white plastron as post-pelagic juveniles and then to the lighter grey-olive carapace and cream-white or yellowish plastron of adults. Their diet consists mainly of swimming crabs, but may also include fish, jellyfish, and an array of mollusks.

The Kemp's ridley has a restricted distribution. Nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico (NMFS et al. 2011). Nesting also occurs in Veracruz and a few historical records exist for Campeche, Mexico (Marquez-Millan 1994). Nesting also occurs regularly in Texas and infrequently in a few other U.S. states. However, historic nesting records in the U.S. are limited to south Texas (Carr 1961; Hildebrand 1963).

Most Kemp's ridley nests located in the U.S. have been found in south Texas, especially Padre Island (Shaver and Caillouet 1998; Shaver 2002, 2005). Nests have been recorded elsewhere in Texas (Shaver 2005; 2006a; 2006b; 2007; 2008), and in Florida (Johnson et al. 1999; Foote and Mueller 2002; Hegna et al. 2006; FWC/FWRI 2010b), Alabama (J. Phillips, Service, personal communication, 2007 cited in NMFS et al. 2011; J. Isaacs, Service, personal communication, 2008 cited in NMFS et al. 2011), Georgia (Williams et al. 2006), South Carolina (Anonymous 1992), and North Carolina (Marquez et al. 1996), but these events are less frequent. Kemp's ridleys inhabit the Gulf of Mexico and the Northwest Atlantic Ocean, as far north as the Grand Banks (Watson et al. 2004) and Nova Scotia (Bleakney 1955). They occur near the Azores and eastern north Atlantic (Deraniyagala 1938; Brongersma 1972; Fontaine et al. 1989; Bolten and Martins 1990) and Mediterranean (Pritchard and Marquez 1973, Brongersma and Carr 1983; Tomas and Raga 2007; Insacco and Spadola 2010).

Juvenile Kemp's ridleys spend on average 2 years in the oceanic zone (NMFS SEFSC unpublished preliminary analysis, July 2004, as cited in NMFS et al. 2011) where they likely live and feed among floating algal communities. They remain here until they reach about 7.9 inches in length (approximately 2 years of age), at which size they enter coastal shallow water habitats (Ogren 1989); however, the time spent in the oceanic zone may vary from 1 to 4 years or perhaps more (Turtle Expert Working Group (TEWG) 2000; Baker and Higgins 2003; Dodge et al. 2003).

No critical habitat has been designated for the Kemp's ridley sea turtle.

2) Life history

Life History – Loggerhead Sea Turtle

Loggerheads are long-lived, slow-growing animals that use multiple habitats across entire ocean basins throughout their life history. This complex life history encompasses terrestrial, nearshore, and open ocean habitats. The three basic ecosystems in which loggerheads live are the:

1. Terrestrial zone (supralittoral) - the nesting beach where both oviposition (egg laying) and embryonic development and hatching occur.

2. Neritic zone - the inshore marine environment (from the surface to the sea floor) where water depths do not exceed 656 feet. The neritic zone generally includes the continental shelf, but in areas where the continental shelf is very narrow or nonexistent, the neritic zone conventionally extends to areas where water depths are less than 656 feet.

3. Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 656 feet.

Maximum intrinsic growth rates of sea turtles are limited by the extremely long duration of the juvenile stage and fecundity. Loggerheads require high survival rates in the juvenile and adult stages, common constraints critical to maintaining long-lived, slow-growing species, to achieve positive or stable long-term population growth (Congdon et al. 1993; Heppell 1998; Crouse 1999; Heppell et al. 1999; 2003; Musick 1999).

Numbers of nests and nesting females are often highly variable from year to year due to a number of factors including environmental stochasticity, periodicity in ocean conditions, anthropogenic effects, and density-dependent and density-independent factors affecting survival, somatic growth, and reproduction (Meylan 1982; Hays 2000; Chaloupka 2001; Solow et al. 2002). Despite these sources of variation, and because female turtles exhibit strong nest site fidelity, a nesting beach survey can provide a valuable assessment of changes in the adult female population, provided that the study is sufficiently long and effort and methods are standardized (Meylan 1982; Gerrodette and Brandon 2000; Reina et al. 2002). **Table 1** summarizes key life history characteristics for loggerheads nesting in the U.S.

Loggerheads nest on ocean beaches and occasionally on estuarine shorelines with suitable sand. Nests are typically laid between the high tide line and the dune front (Routa 1968; Witherington 1986; Hailman and Elowson 1992). Wood and Bjorndal (2000) evaluated four environmental factors (slope, temperature, moisture, and salinity) and found that slope had the greatest influence on loggerhead nest-site selection on a beach in Florida. Loggerheads appear to prefer relatively narrow, steeply sloped, coarse-grained beaches, although nearshore contours may also play a role in nesting beach site selection (Provancha and Ehrhart 1987).

The warmer the sand surrounding the egg chamber, the faster the embryos develop (Mrosovsky and Yntema 1980). Sand temperatures prevailing during the middle third of the incubation period also determine the sex of hatchling sea turtles (Mrosovsky and Yntema 1980). Incubation temperatures near the upper end of the tolerable range produce only female hatchlings while incubation temperatures near the lower end of the tolerable range produce only male hatchlings.

Table 1. Typical values of life history parameters for loggerheads nesting in the U.S. (NMFS and Service 2008).

Life History Trait	**Data**
Clutch size (mean)	100-126 eggs[1]
Incubation duration (varies depending on time of year and latitude)	Range = 42-75 days[2,3]
Pivotal temperature (incubation temperature that produces an equal number of males and females)	84°F[5]
Nest productivity (emerged hatchlings/total eggs) x 100 (varies depending on site specific factors)	45-70 percent[2,6]
Clutch frequency (number of nests/female/season)	3-4 nests[7]
Internesting interval (number of days between successive nests within a season)	12-15 days[8]
Juvenile (<34 inches Curved Carapace Length) sex ratio	65-70 percent female[4]
Remigration interval (number of years between successive nesting migrations)	2.5-3.7 years[9]
Nesting season	late April-early September
Hatching season	late June-early November
Age at sexual maturity	32-35 years[10]
Life span	>57 years[11]

1 Dodd (1988).
2 Dodd and Mackinnon (1999, 2000, 2001, 2002, 2003, 2004).
3 Witherington (2006) (information based on nests monitored throughout Florida beaches in 2005, n = 865).
4 NMFS (2001); Foley (2005).
5 Mrosovsky (1988).
6 Witherington (2006) (information based on nests monitored throughout Florida beaches in 2005, n = 1,680).
7 Murphy and Hopkins (1984); Frazer and Richardson (1985); Hawkes et al. 2005; Scott 2006.
8 Caldwell (1962), Dodd (1988).
9 Richardson et al. (1978); Bjorndal et al. (1983).
10 Snover (2005).
11 Dahlen et al. (2000).

Loggerhead hatchlings pip and escape from their eggs over a 1- to 3-day interval and move upward and out of the nest over a 2- to 4-day interval (Christens 1990). The time from pipping to emergence ranges from 4 to 7 days with an average of 4.1 days (Godfrey and Mrosovsky 1997). Hatchlings emerge from their nests en masse almost exclusively at night, and presumably using decreasing sand temperature as a cue (Hendrickson 1958; Mrosovsky 1968; Witherington et al. 1990). Moran et al. (1999) concluded that a lowering of sand temperatures below a critical threshold, which most typically occurs after nightfall, is the most probable trigger for hatchling emergence from a nest. After an initial emergence, there may be secondary emergences on subsequent nights (Carr and Ogren 1960; Witherington 1986; Ernest and Martin 1993; Houghton and Hays 2001).

Hatchlings use a progression of orientation cues to guide their movement from the nest to the marine environments where they spend their early years (Lohmann and Lohmann 2003). Hatchlings first use light cues to find the ocean. On naturally lighted beaches without artificial lighting, ambient light from the open sky creates a relatively bright horizon compared to the dark silhouette of the dune and vegetation landward of the nest. This contrast guides the hatchlings to the ocean (Daniel and Smith 1947; Limpus 1971; Salmon et al. 1992; Witherington and Martin 1996; Witherington 1997; Stewart and Wyneken 2004).

Life History - Green Sea Turtle

Green sea turtles deposit from one to nine clutches within a nesting season, but the overall average is about 3.3 nests. The interval between nesting events within a season varies around a mean of about 13 days (Hirth 1997). Mean clutch size varies widely among populations. Clutch size varies from 75 to 200 eggs with incubation requiring 48 to 70 days, depending on incubation temperatures. Only occasionally do females produce clutches in successive years. Usually two or more years intervene between breeding seasons (NMFS and Service 1991). Age at sexual maturity is believed to be 20 to 50 years (Hirth 1997).

Life History – Leatherback Sea Turtle

Leatherbacks nest an average of five to seven times within a nesting season, with an observed maximum of 11 nests (NMFS and Service 1992). The interval between nesting events within a season is about 9 to 10 days. Clutch size averages 80 to 85 yolked eggs, with the addition of usually a few dozen smaller, yolkless eggs, mostly laid toward the end of the clutch (Pritchard 1992). Nesting migration intervals of 2 to 3 years were observed in leatherbacks nesting on the Sandy Point National Wildlife Refuge, St. Croix, U.S. Virgin Islands (McDonald and Dutton 1996). Leatherbacks are believed to reach sexual maturity in 13 to 16 years (Dutton et al. 2005; Jones et al. 2011).

Life History – Kemp's Ridley Sea Turtle

Nesting occurs primarily from April into July. Nesting often occurs in synchronized emergences, known as "arribadas" or "arribazones," which may be triggered by high wind speeds, especially north winds, and changes in barometric pressure (Jimenez et al. 2005). Nesting occurs primarily during daylight hours. Clutch size averages 100 eggs and eggs typically take 45 to 58 days to hatch depending on incubation conditions, especially temperatures (Marquez-Millan 1994; Rostal 2007).

Females lay an average of 2.5 clutches within a season (TEWG 1998) and inter-nesting interval generally ranges from 14 to 28 days (Miller 1997; Donna Shaver, Padre Island National Seashore, personal communication, 2007 as cited in NMFS et al. 2011). The mean remigration interval for adult females is 2 years, although intervals of 1 and 3 years are not uncommon (Marquez et al. 1982; TEWG 1998, 2000). Males may not be reproductively active on an annual basis (Wibbels et al. 1991). Age at sexual maturity is believed to be between 10 to 17 years (Snover et al. 2007).

3) Population Dynamics

Population Dynamics – Loggerhead Sea Turtle

The loggerhead occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd 1988). However, the majority of loggerhead nesting is at the western rims of the Atlantic and Indian Oceans. The most recent reviews show that only two loggerhead nesting beaches have greater than 10,000 females nesting per year (Baldwin et al. 2003; Ehrhart et al. 2003; Kamezaki et al. 2003; Limpus and Limpus 2003; Margaritoulis et al. 2003): Peninsular Florida (U.S.) and Masirah (Oman). Those beaches with 1,000 to 9,999 females nesting each year are Georgia through North Carolina (U.S.), Quintana Roo and Yucatán (Mexico), Cape Verde Islands (Cape Verde, eastern Atlantic off Africa), and Western Australia (Australia).

The major nesting concentrations in the U.S. are found in South Florida. However, loggerheads nest from Texas to Virginia. Since 2000, the annual number of loggerhead nests in NC has fluctuated between 333 in 2004 to 1,260 in 2013 (Godfrey, unpublished data). Total estimated nesting in the U.S. has fluctuated between 49,000 and 90,000 nests per year from 1999-2010 (NMFS and Service 2008; FWC/FWRI 2010a). Adult loggerheads are known to make considerable migrations between foraging areas and nesting beaches (Schroeder et al. 2003; Foley et al. 2008). During non-nesting years, adult females from U.S. beaches are distributed in waters off the eastern U.S. and throughout the Gulf of Mexico, Bahamas, Greater Antilles, and Yucatán. From a global perspective, the U.S. nesting aggregation is of paramount importance to the survival of the species, as is the population that nests on islands in the Arabian Sea off Oman (Ross 1982; Ehrhart 1989; Baldwin et al. 2003).

Population Dynamics - Green Sea Turtle

There are an estimated 150,000 females that nest each year in 46 sites throughout the world (NMFS and Service 2007a). In the U.S. Atlantic, the majority of nesting occurs in Florida, where about 100 to 1,000 females are estimated to nest annually (FWC 2009c). In North Carolina, between 4 and 44 green sea turtle nests are laid annually (Godfrey, unpublished data). In the U.S. Pacific, over 90 percent of nesting throughout the Hawaiian archipelago occurs at the French Frigate Shoals, where about 200 to 700 females nest each year (NMFS and Service 1998a). Elsewhere in the U.S. Pacific, nesting takes place at scattered locations in the Commonwealth of the Northern Marianas, Guam, and American Samoa. In the western Pacific, the largest green turtle nesting aggregation in the world occurs on Raine Island, Australia, where thousands of females nest nightly in an average nesting season (Limpus et al. 1993). In the Indian Ocean, major nesting beaches occur in Oman where 30,000 females are reported to nest annually (Ross and Barwani 1995).

Population Dynamics – Leatherback Sea Turtle

A dramatic drop in nesting numbers has been recorded on major nesting beaches in the Pacific. Spotila et al. (2000) have highlighted the dramatic decline and possible extirpation of leatherbacks in the Pacific.

The East Pacific and Malaysia leatherback populations have collapsed. Spotila et al. (1996) estimated that only 34,500 females nested annually worldwide in 1995, which is a dramatic decline from the 115,000 estimated in 1980 (Pritchard 1982). In the eastern Pacific, the major nesting beaches occur in Costa Rica and Mexico. At Playa Grande, Costa Rica, considered the most important nesting beach in the eastern Pacific, numbers have dropped from 1,367 leatherbacks in 1988-1989 to an average of 188 females nesting between 2000-2001 and 2003-2004. In Pacific Mexico, 1982 aerial surveys of adult female leatherbacks indicated this area had become the most important leatherback nesting beach in the world. Tens of thousands of nests were laid on the beaches in 1980s, but during the 2003-2004 seasons a total of 120 nests were recorded. In the western Pacific, the major nesting beaches lie in Papua New Guinea, Papua, Indonesia, and the Solomon Islands. These are some of the last remaining significant nesting assemblages in the Pacific. Compiled nesting data estimated approximately 5,000 to 9,200 nests annually with 75 percent of the nests being laid in Papua, Indonesia.

However, the most recent population size estimate for the North Atlantic alone is a range of 34,000 to 94,000 adult leatherbacks (TEWG 2007). During recent years in Florida, the total number of leatherback nests counted as part of the SNBS program ranged from 540 to 1,797 from 2006-2010 (FWC/FWRI 2010a). Assuming a clutch frequency (number of nests/female/season) of 4.2 in Florida (Stewart 2007), these nests were produced by a range of 128 to 428 females in a given year.

Nesting in the Southern Caribbean occurs in the Guianas (Guyana, Suriname, and French Guiana), Trinidad, Dominica, and Venezuela. The largest nesting populations at present occur in the western Atlantic in French Guiana with nesting varying between a low of 5,029 nests in 1967 to a high of 63,294 nests in 2005, which represents a 92 percent increase since 1967 (TEWG 2007). Trinidad supports an estimated 6,000 leatherbacks nesting annually, which represents more than 80 percent of the nesting in the insular Caribbean Sea. Leatherback nesting along the Caribbean Central American coast takes place between Honduras and Colombia. In Atlantic Costa Rica, at Tortuguero, the number of nests laid annually between 1995 and 2006 was estimated to range from 199 to 1,623. Modeling of the Atlantic Costa Rica data indicated that the nesting population has decreased by 67.8 percent over this time period.

In Puerto Rico, the main nesting areas are at Fajardo (Northeast Ecological Corridor) and Maunabo on the main island of Puerto Rico and on the islands of Culebra and Vieques. Between 1993 and 2010, the number of nests in the Fajardo area ranged from 51 to 456. In the Maunabo area, the number of nests recorded between 2001 and 2010 ranged from a low of 53 in 2002 to a high of 260 in 2009 (Diez 2011). On the island of Culebra, the number of nests ranged from a low 41 in 1996 to a high of 395 in 1997 (Diez 2011). On beaches managed by the Commonwealth of Puerto Rico on the island of Vieques, the Puerto Rico Department of Natural and Environmental Resources recorded annually 14-61 leatherback nests between 1991 and 2000; 145 nests in 2002; 24 in 2003; and 37 in 2005 (Diez 2011). The number of leatherback sea turtle nests recorded on Vieques Island beaches managed by the Service ranged between 13 and 163 during 2001-2010. Using the numbers of nests recorded in Puerto Rico between 1984 and 2005, the Turtle Expert Working Group (2007) estimated a population growth of approximately 10 percent per year. Recorded leatherback nesting on the Sandy Point National Wildlife Refuge on the island of St. Croix, U.S. Virgin Islands, between 1982 and 2010, ranged from a low of 82 in 1986 to a high of 1,008 in 2001 (Garner and Garner 2010). Using the number of observed females at Sandy Point from 1986 to 2004, the Turtle Expert Working Group (2007) estimated a population growth of approximately 10 percent per year. In the British Virgin Islands, annual nest numbers have increased in Tortola from zero to six nests per year in the late 1980s to 35 to 65 nests per year in the 2000s (TEWG 2007).

The most important nesting beach for leatherbacks in the eastern Atlantic lies in Gabon, Africa. It was estimated there were 30,000 nests along 60 miles of Mayumba Beach in southern Gabon during the 1999-2000 nesting season (Billes et al. 2000). Some nesting has been reported in Mauritania, Senegal, the Bijagos Archipelago of Guinea-Bissau, Turtle Islands and Sherbro Island of Sierra Leone, Liberia, Togo, Benin, Nigeria, Cameroon, Sao Tome and Principe, continental Equatorial Guinea, Islands of Corisco in the Gulf of Guinea and the Democratic Republic of the Congo, and Angola. In addition, a large nesting population is found on the island of Bioko (Equatorial Guinea) (Fretey et al. 2007). In North Carolina between the year 2000 and 2013, as many as 9 nests were laid per year (Godfrey, unpublished data).

Population Dynamics – Kemp's Ridley Sea Turtle

Most Kemp's ridleys nest on the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico. Nesting also occurs in Veracruz and Campeche, Mexico, although a small number of Kemp's ridleys nest consistently along the Texas coast (NMFS et al. 2011). In addition, rare nesting events have been reported in Alabama, Florida, Georgia, South Carolina, and North Carolina. Historical information indicates that tens of thousands of ridleys nested near Rancho Nuevo, Mexico, during the late 1940s (Hildebrand 1963). The Kemp's ridley population experienced a devastating decline between the late 1940s and the mid-1980s. The total number of nests per nesting season at Rancho Nuevo remained below 1,000 throughout the 1980s, but gradually began to increase in the 1990s. In 2009, 16,273 nests were documented along the 18.6 miles of coastline patrolled at Rancho Nuevo, and the total number of nests documented for all the monitored beaches in Mexico was 21,144 (USFWS 2010b). In 2011, a total of 20,570 nests were documented in Mexico, 81 percent of these nests were documented in the Rancho Nuevo beach (Burchfield and Peña 2011). In addition, 153 and 199 nests were recorded during 2010 and 2011, respectively, in the United States, primarily in Texas.

4) Status And Distribution

Status and Distribution – All Sea Turtles

Reason for Listing: There are many threats to sea turtles, including nest destruction from natural events, such as tidal surges and hurricanes, or eggs lost to predation by raccoons, foxes, ghost-crabs, and other animals. However, human activity has significantly contributed to the decline of sea turtle populations along the Atlantic Coast and in the Gulf of Mexico (NRC 1990). These factors include the modification, degradation, or loss of nesting habitat by coastal development, artificial lighting, beach driving, and marine pollution and debris. Furthermore, the overharvest of eggs for food, intentional killing of adults and immature turtles for their shells and skin, and accidental drowning in commercial fishing gear are primarily responsible for the worldwide decline in sea turtle populations.

Status and Distribution – Loggerhead Sea Turtle

Range-wide Trend: Five recovery units have been identified in the Northwest Atlantic based on genetic differences and a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries (NMFS and Service 2008). Recovery units are subunits of a listed species that are geographically or otherwise identifiable and essential to the recovery of the species. Recovery units are individually necessary to conserve genetic robustness, demographic robustness, important life history stages, or some other feature necessary for long-term sustainability of the species. The five recovery units identified in the Northwest Atlantic are:

1. Northern Recovery Unit (NRU) - defined as loggerheads originating from nesting beaches from the Florida-Georgia border through southern Virginia (the northern extent of the nesting range);

2. Peninsula Florida Recovery Unit (PFRU) - defined as loggerheads originating from nesting beaches from the Florida-Georgia border through Pinellas County on the west coast of Florida, excluding the islands west of Key West, Florida;

3. Dry Tortugas Recovery Unit (DTRU) - defined as loggerheads originating from nesting beaches throughout the islands located west of Key West, Florida;

4. Northern Gulf of Mexico Recovery Unit (NGMRU) - defined as loggerheads originating from nesting beaches from Franklin County on the northwest Gulf coast of Florida through Texas; and

5. Greater Caribbean Recovery Unit (GCRU) - composed of loggerheads originating from all other nesting assemblages within the Greater Caribbean (Mexico through French Guiana, The Bahamas, Lesser Antilles, and Greater Antilles).

The mtDNA analyses show that there is limited exchange of females among these recovery units (Ehrhart 1989; Foote et al. 2000; NMFS 2001; Hawkes et al. 2005). Male-mediated gene flow appears to be keeping the subpopulations genetically similar on a nuclear DNA level (Francisco-Pearce 2001).

Historically, the literature has suggested that the northern U.S. nesting beaches (NRU and NGMRU) produce a relatively high percentage of males and the more southern nesting beaches (PFRU, DTRU, and GCRU) a relatively high percentage of females (e.g., Hanson et al. 1998; NMFS 2001; Mrosovsky and Provancha 1989). The NRU and NGMRU were believed to play an important role in providing males to mate with females from the more female-dominated subpopulations to the south. However, in 2002 and 2003, researchers studied loggerhead sex ratios for two of the U.S. nesting subpopulations, the northern and southern subpopulations (NGU and PFRU, respectively) (Blair 2005; Wyneken et al. 2005). The study produced interesting results. In 2002, the northern beaches produced more females and the southern beaches produced more males than previously believed. However, the opposite was true in 2003 with the northern beaches producing more males and the southern beaches producing more females in keeping with prior literature. Wyneken et al. (2005) speculated that the 2002 result may have been anomalous; however, the study did point out the potential for males to be produced on the southern beaches. Although this study revealed that more males may be produced on southern recovery unit beaches than previously believed, the Service maintains that the NRU and NGMRU play an important role in the production of males to mate with females from the more southern recovery units.

The NRU is the second largest loggerhead recovery unit within the Northwest Atlantic Ocean DPS. Annual nest totals from northern beaches averaged 5446 nests from 2006 to 2011, a period of near-complete surveys of NRU nesting beaches, representing approximately 1,328 nesting females per year (4.1 nests per female, Murphy and Hopkins 1984) (NMFS and Service 2008). In 2008, nesting in Georgia reached what was a new record at that time (1,646 nests), with a downturn in 2009, followed by yet another record in 2011 (1,987 nests). South Carolina had the two highest years of nesting in the 2000s in 2009 (2,183 nests) and 2010 (3,141 nests). The previous high for that 11-year span was 1,433 nests in 2003. North Carolina had 947 nests in 2011, which is above the average of 765. The Georgia, South Carolina, and North Carolina nesting data come from the seaturtle.org Sea Turtle Nest Monitoring System, which is populated with data input by the State agencies. The loggerhead nesting trend from daily beach surveys was declining significantly at 1.3 percent annually from 1983 to 2007 (NMFS and USFWS, 2008). Overall, there is strong statistical data to suggest the NRU has experienced a long-term decline (NMFS and Service 2008). Currently, however, nesting for the NRU is showing possible signs of stabilizing (76 FR 58868, September 22, 2011).

<u>Recovery Criteria (only the Demographic Recovery Criteria are presented below; for the Listing Factor Recovery Criteria, see NMFS and Service 2008)</u>

1. Number of Nests and Number of Nesting Females
    a. Northern Recovery Unit

   i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is 2 percent or greater resulting in a total annual number of nests of 14,000 or greater for this recovery unit (approximate distribution of nests is North Carolina =14 percent [2,000 nests], South Carolina =66 percent [9,200 nests], and Georgia =20 percent [2,800 nests]); and
   ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

b. Peninsular Florida Recovery Unit
   i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is statistically detectable (one percent) resulting in a total annual number of nests of 106,100 or greater for this recovery unit; and
   ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

c. Dry Tortugas Recovery Unit
   i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is three percent or greater resulting in a total annual number of nests of 1,100 or greater for this recovery unit; and
   ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

d. Northern Gulf of Mexico Recovery Unit
   i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is three percent or greater resulting in a total annual number of nests of 4,000 or greater for this recovery unit (approximate distribution of nests (2002-2007) is Florida= 92 percent [3,700 nests] and Alabama =8 percent [300 nests]); and
   ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

e. Greater Caribbean Recovery Unit

i. The total annual number of nests at a minimum of three nesting assemblages, averaging greater than 100 nests annually (e.g., Yucatán, Mexico; Cay Sal Bank, Bahamas) has increased over a generation time of 50 years; and

ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

2. Trends in Abundance on Foraging Grounds

A network of in-water sites, both oceanic and neritic across the foraging range is established and monitoring is implemented to measure abundance. There is statistical confidence (95 percent) that a composite estimate of relative abundance from these sites is increasing for at least one generation.

3. Trends in Neritic Strandings Relative to In-water Abundance

Stranding trends are not increasing at a rate greater than the trends in in-water relative abundance for similar age classes for at least one generation.

Status and Distribution - Green Sea Turtle

Range-wide Trend: Annual nest totals documented as part of the Florida SNBS program from 1989-2010 have ranged from 435 nests laid in 1993 to 13,225 in 2010. Nesting occurs in 26 counties with a peak along the east coast, from Volusia through Broward Counties. Although the SNBS program provides information on distribution and total abundance statewide, it cannot be used to assess trends because of variable survey effort. Therefore, green turtle nesting trends are best assessed using standardized nest counts made at INBS sites surveyed with constant effort over time (1989-2010). Green sea turtle nesting in Florida is increasing based on 22 years (1989-2010) of INBS data from throughout the state ((FWC/FWRI 2010b). The increase in nesting in Florida is likely a result of several factors, including: (1) a Florida statute enacted in the early 1970s that prohibited the killing of green turtles in Florida; (2) the species listing under the Act afforded complete protection to eggs, juveniles, and adults in all U.S. waters; (3) the passage of Florida's constitutional net ban amendment in 1994 and its subsequent enactment, making it illegal to use any gillnets or other entangling nets in State waters; (4) the likelihood that the majority of Florida green turtles reside within Florida waters where they are fully protected; (5) the protections afforded Florida green turtles while they inhabit the waters of other nations that have enacted strong sea turtle conservation measures (e.g., Bermuda); and (6) the listing of the species on Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which stopped international trade and reduced incentives for illegal trade from the U.S (NMFS and Service 2007a).

Recovery Criteria

The U.S. Atlantic population of green sea turtles can be considered for delisting if, over a period of 25 years, the following conditions are met:

1. The level of nesting in Florida has increased to an average of 5,000 nests per year for at least six years. Nesting data must be based on standardized surveys;

2. At least 25 percent (65 miles) of all available nesting beaches (260 miles) is in public ownership and encompasses at least 50 percent of the nesting activity;

3. A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds; and

4. All priority one tasks identified in the recovery plan have been successfully implemented.

Status and Distribution - Leatherback Sea Turtle

Range-wide Trend: Pritchard (1982) estimated 115,000 nesting females worldwide, of which 60 percent nested along the Pacific coast of Mexico. Declines in leatherback nesting have occurred over the last two decades along the Pacific coasts of Mexico and Costa Rica. The Mexican leatherback nesting population, once considered to be the world's largest leatherback nesting population (historically estimated to be 65 percent of the worldwide population), is now less than 1 percent of its estimated size in 1980. Spotila et al. (1996) estimated the number of leatherback sea turtles nesting on 28 beaches throughout the world from the literature and from communications with investigators studying those beaches. The estimated worldwide population of leatherbacks in 1995 was about 34,500 females on these beaches with a lower limit of about 26,200, and an upper limit of about 42,900. This is less than one-third the 1980 estimate of 115,000. Leatherbacks are rare in the Indian Ocean and in very low numbers in the western Pacific Ocean. The most recent population size estimate for the North Atlantic is a range of 34,000 to 94,000 adult leatherbacks (TEWG 2007). The largest population is in the western Atlantic. Using an age-based demographic model, Spotila et al. (1996) determined that leatherback populations in the Indian Ocean and western Pacific Ocean cannot withstand even moderate levels of adult mortality and that the Atlantic populations are being exploited at a rate that cannot be sustained. They concluded that leatherbacks are on the road to extinction and further population declines can be expected unless action is taken to reduce adult mortality and increase survival of eggs and hatchlings.

In the western Atlantic, the U.S., nesting populations occur in Florida, Puerto Rico, and the U.S. Virgin Islands. In Florida, the SNBS program documented an increase in leatherback nesting numbers from 98 nests in 1989 to between 453 and 1,747 nests per season in the early 2000s (FWC 2009a; Stewart and Johnson 2006). Although the SNBS program provides information on distribution and total abundance statewide, it cannot be used to assess trends because of variable survey effort. Therefore, leatherback nesting trends are best assessed using standardized nest counts made at INBS sites surveyed with constant effort over time (1989-2010). Under the INBS program, approximately 30 percent of Florida's SNBS beach length is surveyed. The INBS nest counts represent approximately 34 percent of known leatherback nesting in Florida. An analysis of the INBS data has shown an exponential increase in leatherback sea turtle nesting in Florida since 1989. From 1989 through 2010, the annual number of leatherback sea turtle nests at the core set of index beaches ranged from 27 to 615 (FWC 2010b). Using the numbers of nests recorded from 1979 through 2009, Stewart et al. (2011) estimated a population growth of approximately 10.2 percent per year. In Puerto Rico, the main nesting areas are at Fajardo (Northeast Ecological Corridor) and Maunabo on the main island and on the islands of Culebra and Vieques. Nesting ranged from 51 to 456 nests between 2001 and 2010 (Diez 2011). In the U.S. Virgin Islands, leatherback nesting on Sandy Point National Wildlife Refuge on the island of St. Croix ranged from 143 to 1,008 nests between 1990 and 2005 (TEWG 2007; NMFS and Service 2007b).

Recovery Criteria

The U.S. Atlantic population of leatherbacks can be considered for delisting if the following conditions are met:

1. The adult female population increases over the next 25 years, as evidenced by a statistically significant trend in the number of nests at Culebra, Puerto Rico, St. Croix, U.S. Virgin Islands, and along the east coast of Florida;
2. Nesting habitat encompassing at least 75 percent of nesting activity in U.S. Virgin Islands, Puerto Rico, and Florida is in public ownership; and
3. All priority one tasks identified in the recovery plan have been successfully implemented.

Status and Distribution – Kemp's Ridley Sea Turtle

Nesting aggregations of Kemp's ridleys at Rancho Nuevo were discovered in 1947, and the adult female population was estimated to be 40,000 or more individuals based on a film by Andres Herrera (Hildebrand 1963; Carr 1963). Within approximately 3 decades, the population had declined to 924 nests and reached the lowest recorded nest count of 702 nests in 1985. Since the mid-1980s, the number of nests observed at Rancho Nuevo and nearby beaches has increased 15 percent per year (Heppell et al. 2005), allowing cautious optimism that the population is on its way to recovery. This increase in nesting can be attributed to full protection of nesting females and their nests in Mexico resulting from a bi-national effort between Mexico and the U.S. to prevent the extinction of the Kemp's ridley, the requirement to use Turtle Excluder Devices (TEDs) in shrimp trawls both in the U.S. and Mexico, and decreased shrimping effort (NMFS et al. 2011; Heppell et al. 2005).

Recovery Criteria (only the Demographic Recovery Criteria are presented below; for the Listing Factor Recovery Criteria, see NMFS et al. 2011)

The recovery goal is to conserve and protect the Kemp's ridley sea turtle so that protections under the Act are no longer necessary and the species can be removed from the List of Endangered and Threatened Wildlife. Biological recovery criteria form the basis from which to gauge whether the species should be reclassified to threatened (i.e., downlisted) or delisted, whereas the listing factor criteria ensure that the threats affecting the species are controlled or eliminated.

Downlisting Criteria

1. A population of at least 10,000 nesting females in a season (as estimated by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained. Methodology and capacity to implement and ensure accurate nesting female counts have been developed.

2. Recruitment of at least 300,000 hatchlings to the marine environment per season at the three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained to ensure a minimum level of known production through *in situ* incubation, incubation in corrals, or a combination of both.

Delisting Criteria

1. An average population of at least 40,000 nesting females per season (as measured by clutch frequency per female per season and annual nest counts) over a 6-year period distributed among nesting beaches in Mexico and the U.S. is attained. Methodology and capacity to ensure accurate nesting female counts have been developed and implemented.

2. Ensure average annual recruitment of hatchlings over a 6-year period from *in situ* nests and beach corrals is sufficient to maintain a population of at least 40,000 nesting females per nesting season distributed among nesting beaches in Mexico and the U.S into the future. This criterion may rely on massive synchronous nesting events (i.e., arribadas) that will swamp predators as well as rely on supplemental protection in corrals and facilities.

5) Analysis of the Species/Critical Habitat Likely to be Affected

The loggerhead sea turtle, the green sea turtle, the leatherback sea turtle, and the Kemp's ridley sea turtle are currently listed because of their reduced population sizes caused by overharvest and habitat loss with continuing anthropogenic threats from commercial fishing, disease, and degradation of remaining habitat.

Barrier islands and inlets are complex and dynamic coastal systems that are continually responding to sediment supply, waves, and fluctuations in sea level. The location and shape of the beaches of barrier islands perpetually adjusts to these physical forces. Waves that strike a barrier island at an angle, for instance, generate a longshore current that carries sediment along the shoreline. Cross-shore currents carry sediment perpendicular to the shoreline. Wind moves sediment across the dry beach, dunes and island interior. During storm events, overwash may breach the island at dune gaps or other weak spots, depositing sediments on the interior and back sides of islands, increasing island elevation and accreting the soundside shoreline.

Tidal inlets play a vital role in the dynamics and processes of barrier islands. Sediment is transferred across inlets from island to island via the tidal shoals or deltas. The longshore sediment transport often causes barrier spits to accrete, shifting inlets towards the neighboring island. Flood tidal shoals that are left behind by the migrating inlet are typically incorporated into the soundside shoreline and marshes of the island, widening it considerably. Many inlets have a cycle of inlet migration, breaching of the barrier spit during a storm, and closure of the old inlet with the new breach becoming the new inlet. Barrier spits tend to be low in elevation, sparse in vegetation, and repeatedly submerged by high and storm tides.

The Service and the NMFS share Federal jurisdiction for sea turtles under the Act. The Service has responsibility for sea turtles on the nesting beach. NMFS has jurisdiction for sea turtles in the marine environment. In accordance with the Act, the Service completes consultations with all Federal agencies for actions that may adversely affect sea turtles on the nesting beach. The Service's analysis only addresses activities that may impact nesting sea turtles, their nests and eggs, and hatchlings as they emerge from the nest and crawl to the sea. NMFS assesses and consults with Federal agencies concerning potential impacts to sea turtles in the marine environment, including updrift and downdrift nearshore areas affected by sand placement projects on the beach.

The proposed action has the potential to adversely affect nesting females, nests, and hatchlings on the beach within the proposed Action Area. Potential effects include destruction of nests deposited within the boundaries of the proposed project, harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities, disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting or presence of the groin, and behavior modification of nesting females during the nesting season resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs due to escarpment formation or presence of the groin within the Action Area. The quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest. The presence of the groin could affect the movement of sand by altering the natural coastal processes and could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest and crawl to the ocean.

Some individuals in a population are more "valuable" than others in terms of the number of offspring they are expected to produce. An individual's potential for contributing offspring to future generations is its reproductive value. Because of delayed sexual maturity, reproductive longevity, and low survivorship in early life stages, nesting females are of high value to a population. The loss of a nesting female in a small recovery unit would represent a significant loss to the recovery unit. The reproductive value for a nesting female has been estimated to be approximately 253 times greater than an egg or a hatchling (NMFS and Service 2008). However, the construction of a groin and sand placement action includes avoidance and minimization measures that reduce the possibility of mortality of a nesting female on the beach as a result of the project. Therefore, we do not anticipate the loss of any nesting females on the beach as a result of the project.

With regard to indirect loss of eggs and hatchlings, on most beaches, nesting success typically declines for the first year or two following sand placement, even though more nesting habitat is available for turtles (Trindell et al. 1998; Ernest and Martin 1999; Herren 1999). Reduced nesting success on constructed beaches has been attributed to increased sand compaction, escarpment formation, and changes in beach profile (Nelson et al. 1987; Crain et al. 1995; Lutcavage et al. 1997; Steinitz et al. 1998; Ernest and Martin 1999; Rumbold et al. 2001). In addition, even though constructed beaches are wider, nests deposited there may experience higher rates of wash out than those on relatively narrow, steeply sloped beaches (Ernest and

Martin 1999). This occurs because nests on constructed beaches are more broadly distributed than those on natural beaches, where they tend to be clustered near the base of the dune. Nests laid closest to the waterline on constructed beaches may be lost during the first year or two following construction as the beach undergoes an equilibration process during which seaward portions of the beach are lost to erosion. As a result, the project may be anticipated to result in decreased nesting and loss of nests that are laid within the Action Area for two subsequent nesting seasons following the completion of the proposed sand placement. However, it is unknown whether nests that would have been laid in an Action Area during the two subsequent nesting seasons had the project not occurred are actually lost from the population, or if nesting is simply displaced to adjacent beaches. Regardless, eggs and hatchlings have a low reproductive value; each egg or hatchling has been estimated to have only 0.004 percent of the value of a nesting female (NMFS and Service 2008). Thus, even if the majority of the eggs and hatchlings that would have been produced on the project beach are not realized for up to 2 years following project completion, the Service would not expect this loss to have a significant effect on the recovery and survival of the species, for the following reasons: 1) some nesting is likely just displaced to adjacent non-project beaches, 2) not all eggs will produce hatchlings, and 3) destruction and/or failure of nests will not always result from a sand placement project. A variety of natural and unknown factors negatively affect incubating egg clutches, including tidal inundation, storm events, and predation.

During project construction, direct mortality of the developing embryos in nests within the Action Area may occur for nests that are missed and not relocated or marked for avoidance. The exact number of these missed nests is not known. However, in two separate monitoring programs on the east coast of Florida where hand digging was performed to confirm the presence of nests and thus reduce the chance of missing nests through misinterpretation, trained observers still missed about 6 to 8 percent of the nests because of natural elements (Martin 1992; Ernest and Martin 1993). This must be considered a conservative number, because missed nests are not always accounted for. In another study, Schroeder (1994) found that even under the best of conditions, about 7 percent of nests can be misidentified as false crawls by highly experienced sea turtle nest surveyors. Missed nests are usually identified by signs of hatchling emergences or egg or hatchling predation in areas where no nest was previously documented. Signs of hatchling emergence are very easily obliterated by the same elements that interfere with detection of nests. Regardless, eggs and hatchlings have a low reproductive value; each egg or hatchling has been estimated to have only 0.004 percent of the value of a nesting female (NMFS and Service 2008). Thus, even if, for example, the number of missed nests approaches twice the rate mentioned above, the Service would not expect this loss to have a significant effect on the recovery and survival of the species, for the following reasons: 1) not all eggs in all unmarked nests will produce hatchlings, and 2) destruction and/or failure of a missed nest will not always result from a construction project. A variety of natural and unknown factors negatively affect incubating egg clutches, including tidal inundation, storm events, predation, accretion of sand, and erosional processes. The loss of all life stages of sea turtles including eggs are considered "take" and minimization measures are required to avoid and minimize all life stages. During project construction, predators of eggs and nestlings may be attracted to the Action Area due to food waste from the construction crew.

The presence of the groin may create a physical obstacle to nesting sea turtles. The impact of nesting females interacting with the groin in the marine environment will be analyzed by NMFS in their consultation. As a result, the groin is anticipated to result in decreased nesting and loss of nests that do get laid within the Action Area for all subsequent nesting seasons following the completion of the proposed project. However, it is unknown whether nests that would have been laid in the Action Area had the project not occurred are actually lost from the population, or if nesting is simply displaced to adjacent beaches. Regardless, eggs and hatchlings have a low reproductive value; each egg or hatchling has been estimated to have only 0.004 percent of the value of a nesting female (NMFS and Service 2008). The Service would not expect this loss to have a significant effect on the recovery and survival of the species, for the following reasons: 1) some nesting is likely just displaced to adjacent non-project beaches, 2) not all eggs will produce hatchlings, and 3) destruction and/or failure of nests will not always result from the construction project. A variety of natural and unknown factors negatively affect incubating egg clutches, including tidal inundation, storm events, and predation.

The DEIS states that the terminal groin was designed to include large voids between the stones to facilitate sediment movement though the structures. The interaction between the groin and the hydrodynamics of tide and current often results in the alteration of the beach profile seaward and in the immediate vicinity of the structure (Pilkey and Wright 1988; Terchunian 1988; Tait and Griggs 1990; Plant and Griggs 1992); including increased erosion seaward of structures, increased longshore currents that move sand away from the area, loss of interaction between the dune and ocean, and concentration of wave energy at the ends of an armoring structure (Schroeder and Mosier 1996). These changes or combination of changes can have various detrimental effects on sea turtles and their nesting habitat.

B. Environmental Baseline

1) Status of Sea Turtle Species within the Action Area

The loggerhead sea turtle nesting and hatching season for North Carolina beaches extends from May 1 through November 15. Incubation ranges from about 45 to 95 days. See **Table 2** for data on observed loggerhead sea turtle nests on Ocean Isle and Holden Beach. Data was provided in the January 2015 BA unless otherwise noted.

Table 2. Number of loggerhead nests observed between 1980 and 2012 on Ocean Isle and Holden Beach.

Year	Number of Loggerhead Nests	
	Ocean Isle Beach	Holden Beach
2009	25	23
2010	23	30
2011	22	30
2012	24	46
2013	36*	73*
2014	4*	19*

*data from www.seaturtle.org, accessed on July 17, 2015

Critical Habitat Unit LOGG-T-NC-08

For the Northern Recovery Unit, the Service designated 393.7 km (244.7 miles) of Atlantic Ocean shoreline in North Carolina, South Carolina, and Georgia, encompassing approximately 86 percent of the documented nesting (numbers of nests) within the recovery unit.

This critical habitat unit is one of 38 designated critical habitat units for the Northern Recovery Unit of the Northwest Atlantic DPS. In North Carolina, 96.1 shoreline miles (154.6 km) of critical habitat for nesting loggerhead sea turtles was designated. Some of this acreage has been affected recently by activities such as beach nourishment, sandbag revetment construction, and groin construction. However, with the exception of beach nourishment activities and recreational activities, most of the critical habitat units in North Carolina remain relatively unaffected by development.

The green sea turtle nesting and hatching season North Carolina beaches extends from May 15 through November 15. Incubation ranges from about 45 to 75 days. One green sea turtle nest was reported on Holden Beach in both 2010 and 2013 (data from NCWRC).

The leatherback sea turtle nesting and hatching season on North Carolina beaches extends from April 15 through November 15. Incubation ranges from about 55 to 75 days. There was one leatherback nest reported on Holden Beach in 2010.

The Kemp's ridley sea turtle nesting and hatchling season on North Carolina beaches appears to be similar to other species. Incubation ranges from 45 to 58 days. One Kemp's ridley nest was observed on Ocean Isle Beach in 2010.

2) Factors Affecting the Species Environment within the Action Area

A number of recent and on-going beach disturbance activities have altered the proposed Action Area and, to a greater extent, the North Carolina coastline, and many more are proposed along the coastline for the near future. **Table 3** lists the most recent projects, within the past 5 years.

Table 3. Actions that have occurred in the Action Area in the last five years.

Year	Species Impacted	Project Type	Anticipated Take
Regularly, most recently in 2014 and 2010.	Loggerhead, green, leatherback, and Kemp's ridley sea turtle, piping plover, red knot, seabeach amaranth	Ocean Isle Beach Coastal Storm Damage Reduction (CSDR) Project. Dredging of AIWW Inlet crossing and Shallotte Inlet, and associated beach nourishment	Up to 17,100 lf of beach shoreline and an unknown amount of inlet habitats
2014	Loggerhead, green, leatherback, and Kemp's ridley sea turtle, piping plover, red knot, seabeach amaranth	Beach bulldozing	Approximately 1,200 lf of beach shoreline
Various Years, beginning in approximately 2005	Loggerhead, green, Kemp's ridley, and leatherback sea turtle, piping plover, red knot, seabeach amaranth	Sandbag placement in front of several properties.	Approximately 1,400 lf of beach shoreline.

Nourishment activities widen beaches, change their sedimentology and stratigraphy, alter coastal processes and often plug dune gaps and remove overwash areas.

Inlet dredging activities alter the sediment dynamics on adjacent shorelines and stabilize these dynamic environments; beach disposal of dredge material further alters the natural habitat adjacent to inlets. Estuarine dredging of navigational channels can alter water circulation patterns and sediment transport pathways, as well as increase the frequency and magnitude of boat wakes; sound-side sand or mud flats may be impacted by increased erosion rates as a result. The Corps has regularly dredged Shallotte Inlet every few years since 2001 as part of the Ocean Isle Coastal Storm Damage Reduction (CSDR), and the sediment has been disposed on Ocean Isle.

Beach scraping or bulldozing can artificially steepen beaches, stabilize dune scarps, plug dune gaps, and redistribute sediment distribution patterns. Artificial dune building, often a product of beach scraping, removes low-lying overwash areas and dune gaps. As chronic erosion catches up to structures throughout the Action Area, artificial dune systems are constructed and maintained to protect beachfront structures either by sand fencing or fill placement. Beach scraping or bulldozing has been frequent on North Carolina beaches in recent years, in response to storms and the continuing retreat of the shoreline with rising sea level. These activities primarily occur during the winter months. Artificial dune or berm systems have been constructed and maintained in several areas. These dunes make the artificial dune ridge function like a seawall that blocks natural beach retreat, evolution, and overwash.

Sandbags and revetments are vertical structures built parallel to the beach in front of buildings, roads, and other facilities to protect them from erosion. However, these structures often accelerate erosion by causing scouring in front of and downdrift from the structure (Hayes and Michel 2008), which can eliminate sea turtle nesting habitat. Geotubes (long cylindrical bags made of high-strength permeable fabric and filled with sand) and sandbag revetments are softer alternatives, but act as barriers by preventing overwash. There are two existing rock revetments along the coast of North Carolina: one at Fort Fisher (approximately 3,040 lf), and another along Carolina Beach (approximately 2,050 lf). Sandbags and sandbag revetments have been placed along at least 1,400 lf of the Action Area on Ocean Isle Beach. A sandbag revetment at least 1,500 lf long was constructed in 2015 at the north end of North Topsail Beach.

<u>*Threats to Sea Turtles*</u>

Coastal Development

Loss of sea turtle nesting habitat related to coastal development has had the greatest impact on nesting sea turtles. Beachfront development not only causes the loss of suitable nesting habitat, but can result in the disruption of powerful coastal processes accelerating erosion and interrupting the natural shoreline migration (National Research Council 1990b). This may in turn cause the need to protect upland structures and infrastructure by armoring, groin placement, beach emergency berm construction and repair, and beach nourishment, all of which cause changes in, additional loss of, or impact to the remaining sea turtle habitat.

Hurricanes and Storms

Hurricanes and other large storms were probably responsible for maintaining coastal beach habitat upon which sea turtles depend through repeated cycles of destruction, alteration, and recovery of beach and dune habitat. Hurricanes and large storms generally produce damaging winds, storm tides and surges, and rain, which can result in severe erosion of the beach and dune systems. Overwash and blowouts are common on barrier islands.

Hurricanes and other storms can result in the direct loss of sea turtle nests, either by erosion or washing away of the nests by wave action and inundation or "drowning" of the eggs or pre-emergent hatchlings within the nest, or indirectly by causing the loss of nesting habitat. Depending on their frequency, storms can affect sea turtles on either a short-term basis (nests lost for one season and/or temporary loss of nesting habitat) or long term, if frequent (habitat unable to recover). The manner in which hurricanes affect sea turtle nesting also depends on their characteristics (winds, storm surge, rainfall), the time of year (within or outside of the nesting season), and where the northeast edge of the hurricane crosses land.

Because of the limited remaining nesting habitat in a natural state with no immediate development landward of the sandy beach, frequent or successive severe weather events could threaten the ability of certain sea turtle populations to survive and recover. Sea turtles evolved under natural coastal environmental events such as hurricanes. The extensive amount of predevelopment coastal beach and dune habitat allowed sea turtles to survive even the most severe hurricane events. It is only within the last 20 to 30 years that the combination of habitat loss to beachfront development and destruction of remaining habitat by hurricanes has increased the threat to sea turtle survival and recovery. On developed beaches, typically little space remains for sandy beaches to become reestablished after periodic storms. While the beach itself moves landward during such storms, reconstruction or persistence of structures at their pre-storm locations can result in a loss of nesting habitat.

Erosion

A critically eroded area is a segment of shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost. It is important to note that for an erosion problem area to be critical there must be an existing threat to or loss of one of four specific interests – upland development, recreation, wildlife habitat, or important cultural resources.

Beachfront Lighting

Artificial lights along a beach can deter females from coming ashore to nest or misdirect females trying to return to the surf after a nesting event. A significant reduction in sea turtle nesting activity has been documented on beaches illuminated with artificial lights (Witherington 1992). Artificial beachfront lighting may also cause disorientation (loss of bearings) and misorientation (incorrect orientation) of sea turtle hatchlings (Philibosian 1976; Mann 1977; Witherington and Martin 1996). Visual signs are the primary sea-finding mechanism for hatchlings (Mrosovsky and Carr 1967; Mrosovsky and Shettleworth 1968; Dickerson and Nelson 1989; Witherington and Bjorndal 1991) . The emergence from the nest and crawl to the sea is one of the most critical periods of a sea turtle's life. Hatchlings that do not make it to the sea quickly become food for ghost crabs, birds, and other predators, or become dehydrated and may never reach the sea. In addition, research has documented significant reduction in sea turtle nesting activity on beaches illuminated with artificial lights (Witherington 1992). During the 2010 sea turtle nesting season in Florida, over 47,000 turtle hatchlings were documented as being disoriented (FWC/FWRI 2011).

Predation

Predation of sea turtle eggs and hatchlings by native and introduced species occurs on almost all nesting beaches. Predation by a variety of predators can considerably decrease sea turtle nest hatching success. The most common predators in the southeastern U.S. are ghost crabs (*Ocypode quadrata*), raccoons (*Procyon lotor*), feral hogs (*Sus scrofa*), foxes (*Urocyon cinereoargenteus* and *Vulpes vulpes*), coyotes (*Canis latrans*), armadillos (*Dasypus novemcinctus*), and fire ants (*Solenopsis invicta*) (Dodd 1988; Stancyk 1995). In the absence of nest protection programs in a number of locations throughout the southeast U.S., raccoons may depredate up to 96 percent of all nests deposited on a beach (Davis and Whiting 1977; Hopkins and Murphy 1980; Stancyk et al. 1980; Talbert et al. 1980; Schroeder 1981; Labisky et al. 1986).

Beach Driving

The operation of motor vehicles on the beach affects sea turtle nesting by interrupting or striking a female turtle on the beach, headlights disorienting or misorienting emergent hatchlings, vehicles running over hatchlings attempting to reach the ocean, and vehicle tracks traversing the beach that interfere with hatchlings crawling to the ocean. Hatchlings appear to become diverted not because they cannot physically climb out of the rut (Hughes and Caine 1994), but because the sides of the track cast a shadow and the hatchlings lose their line of sight to the ocean horizon (Mann 1977). The extended period of travel required to negotiate tire tracks and ruts may increase the susceptibility of hatchlings to dehydration and depredation during migration to the ocean (Hosier et al. 1981). Driving on the beach can cause sand compaction which may result in adverse impacts on nest site selection, digging behavior, clutch viability, and emergence by hatchlings, decreasing nest success and directly killing pre-emergent hatchlings (Mann 1977; Nelson and Dickerson 1987; Nelson 1988).

The physical changes and loss of plant cover caused by vehicles on dunes can lead to various degrees of instability, and therefore encourage dune migration. As vehicles move either up or down a slope, sand is displaced downward, lowering the trail. Since the vehicles also inhibit plant growth, and open the area to wind erosion, dunes may become unstable, and begin to migrate. Unvegetated sand dunes may continue to migrate across stable areas as long as vehicle traffic continues. Vehicular traffic through dune breaches or low dunes on an eroding beach may cause an accelerated rate of overwash and beach erosion (Godfrey et al. 1978). If driving is required, the area where the least amount of impact occurs is the beach between the low and high tide water lines. Vegetation on the dunes can quickly reestablish provided the mechanical impact is removed.

Climate Change

The varying and dynamic elements of climate science are inherently long term, complex, and interrelated. Regardless of the underlying causes of climate change, glacial melting and expansion of warming oceans are causing sea level rise, although its extent or rate cannot as yet be predicted with certainty. At present, the science is not exact enough to precisely predict when and where climate impacts will occur. Although we may know the direction of change, it may not be possible to predict its precise timing or magnitude. These impacts may take place gradually or episodically in major leaps.

Climate change is evident from observations of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising sea level, according to the Intergovernmental Panel on Climate Change Report (IPCC 2007a). The IPCC Report (2007a) describes changes in natural ecosystems with potential widespread effects on many organisms, including marine mammals and migratory birds. The potential for rapid climate change poses a significant challenge for fish and wildlife conservation. Species' abundance and distribution are dynamic, relative to a variety of factors, including climate. As climate changes, the abundance and distribution of fish and wildlife will also change. Highly specialized or endemic species are likely to be most susceptible to the stresses of changing climate. Based on these findings and other similar studies, the U.S. Department of the Interior (DOI) requires agencies under its direction to consider potential climate change effects as part of their long-range planning activities (USFWS 2007).

In the southeastern U.S., climatic change could amplify current land management challenges involving habitat fragmentation, urbanization, invasive species, disease, parasites, and water management. Global warming will be a particular challenge for endangered, threatened, and other "at risk" species. It is difficult to estimate, with any degree of precision, which species will be affected by climate change or exactly how they will be affected. The Service will use Strategic Habitat Conservation planning, an adaptive science-driven process that begins with explicit trust resource population objectives, as the framework for adjusting our management strategies in response to climate change (USFWS 2006). As the level of information increases relative to the effects of global climate change on sea turtles and its designated critical habitat, the Service will have a better basis to address the nature and magnitude of this potential threat and will more effectively evaluate these effects to the range-wide status of sea turtles.

Temperatures are predicted to rise from 1.6°F to 9°F for North America by the end of this century (IPCC 2007a, b). Alterations of thermal sand characteristics could result in highly female-biased sex ratios because sea turtles exhibit temperature dependent sex determination (e.g., Glen and Mrosovsky 2004; Hawkes et al. 2008).

Along developed coastlines, and especially in areas where shoreline protection structures have been constructed to limit shoreline movement, rising sea levels will cause severe effects on nesting females and their eggs. Erosion control structures can result in the permanent loss of dry nesting beach or deter nesting females from reaching suitable nesting sites (National Research Council 1990a). Nesting females may deposit eggs seaward of the erosion control structures potentially subjecting them to repeated tidal inundation or washout by waves and tidal action.

Based on the present level of available information concerning the effects of global climate change on the status of sea turtles and their designated critical habitat, the Service acknowledges the potential for changes to occur in the Action Area, but presently has no basis to evaluate if or how these changes are affecting sea turtles or their designated critical habitat. Nor does our present knowledge allow the Service to project what the future effects from global climate change may be or the magnitude of these potential effects.

Recreational Beach Use

Human presence on or adjacent to the beach at night during the nesting season, particularly recreational activities, can reduce the quality of nesting habitat by deterring or disturbing and causing nesting turtles to avoid otherwise suitable habitat. In addition, human foot traffic can make a beach less suitable for nesting and hatchling emergence by increasing sand compaction and creating obstacles to hatchlings attempting to reach the ocean (Hosier et al. 1981).

The use and storage of lounge chairs, cabanas, umbrellas, catamarans, and other types of recreational equipment on the beach at night can also make otherwise suitable nesting habitat unsuitable by hampering or deterring nesting by adult females and trapping or impeding hatchlings during their nest to sea migration. The documentation of non-nesting emergences (also referred to as false crawls) at these obstacles is becoming increasingly common as more recreational beach equipment is left on the beach at night. Sobel (2002) describes nesting turtles being deterred by wooden lounge chairs that prevented access to the upper beach.

Sand Placement

Sand placement projects may result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, sand grain size, sand grain shape, and sand grain mineral content if the placed sand is dissimilar from the original beach sand (Nelson and Dickerson 1988a). These changes could result in adverse impacts on sea turtle nest site selection, digging behavior, clutch viability, and hatchling emergence (Nelson and Dickerson 1987; Nelson 1988).

Beach nourishment projects create an elevated, wider, and unnatural flat slope berm. Sea turtles nest closer to the water the first few years after nourishment because of the altered profile (and perhaps unnatural sediment grain size distribution) (Ernest and Martin 1999; Trindell 2005)

Beach compaction and unnatural beach profiles resulting from beach nourishment activities could negatively impact sea turtles regardless of the timing of projects. Sand compaction may increase the length of time required for female sea turtles to excavate nests and cause increased physiological stress to the animals (Nelson and Dickerson 1988b). These impacts can be minimized by using suitable sand.

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

In-water and Shoreline Alterations

Many navigable mainland or barrier island tidal inlets along the Atlantic and Gulf of Mexico coasts are stabilized with jetties or groins. Jetties are built perpendicular to the shoreline and extend through the entire nearshore zone and past the breaker zone to prevent or decrease sand deposition in the channel (Kaufman and Pilkey 1979). Groins are also shore-perpendicular structures that are designed to trap sand that would otherwise be transported by longshore currents and can cause downdrift erosion (Kaufman and Pilkey 1979).

These in-water structures have profound effects on adjacent beaches (Kaufman and Pilkey 1979). Jetties and groins placed to stabilize a beach or inlet prevent normal sand transport, resulting in accretion of sand on updrift beaches and acceleration of beach erosion downdrift of the structures (Komar 1983; Pilkey et al. 1984). Witherington et al. (2005) found a significant negative relationship between loggerhead nesting density and distance from the nearest of 17 ocean inlets on the Atlantic coast of Florida. The effect of inlets in lowering nesting density was observed both updrift and downdrift of the inlets, leading researchers to propose that beach instability from both erosion and accretion may discourage sea turtle nesting.

Following construction, the presence of groins and jetties may interfere with nesting turtle access to the beach, result in a change in beach profile and width (downdrift erosion, loss of sandy berms, and escarpment formation), trap hatchlings, and concentrate predatory fishes, resulting in higher probabilities of hatchling predation. In addition to decreasing nesting habitat suitability, construction or repair of groins and jetties during the nesting season may result in the destruction of nests, disturbance of females attempting to nest, and disorientation of emerging hatchlings from project lighting.

Threats to loggerhead sea turtle terrestrial habitat

Recreational beach use: beach cleaning, human presence (e.g., dog beach, special events, piers, and recreational beach equipment);

Beach driving: essential and nonessential off-road vehicles, all-terrain vehicles, and recreational access and use;

Predation: depredation of eggs and hatchlings by native and nonnative predators;

Beach sand placement activities: beach nourishment, beach restoration, inlet sand bypassing, dredge material disposal, dune construction, emergency sand placement after natural disaster, berm construction, and dune and berm planting;

In-water and shoreline alterations: artificial in-water and shoreline stabilization measures (e.g., in-water erosion control structures, such as groins, breakwaters, jetties), inlet relocation, inlet dredging, nearshore dredging, and dredging and deepening channels;

Coastal development: residential and commercial development and associated activities including beach armoring (e.g., sea walls, geotextile tubes, rock revetments, sandbags, emergency temporary armoring); and activities associated with construction, repair, and maintenance of upland structures, stormwater outfalls, and piers;

Artificial lighting: direct and indirect lighting, skyglow, and bonfires;

Beach erosion: erosion due to aperiodic, short-term weather-related erosion events, such as atmospheric fronts, northeasters, tropical storms, and hurricanes;

Climate change: includes sea level rise;

Habitat obstructions: tree stumps, fallen trees, and other debris on the beach; nearshore sand bars; and ponding along beachfront seaward of dry beach;

Human-caused disasters and response to natural and human-caused disasters: oil spills, oil spill response including beach cleaning and berm construction, and debris cleanup after natural disasters;

Military testing and training activities: troop presence, pyrotechnics and nighttime lighting, vehicles and amphibious watercraft usage on the beach, helicopter drops and extractions, live fire exercises, and placement and removal of objects on the beach.

C. Effects of the Action

1) Factors to be Considered

Proximity of action: Construction of the groin and sand placement activities would occur within and adjacent to nesting habitat for sea turtles and dune habitats that ensure the stability and integrity of the nesting beach. Specifically, the project would potentially impact loggerhead, green, leatherback, and Kemp's ridley nesting females, their nests, and hatchling sea turtles.

Distribution: Construction and presence of the groin and sand placement activities may impact nesting and hatchling sea turtles and sea turtle nests occurring along Ocean Isle Beach and Holden Beach adjacent to the Atlantic Ocean and Shallotte Inlet. The Service expects the proposed construction activities could directly and indirectly affect the availability of habitat for nesting and hatchling sea turtles.

Timing: The timing of the sand placement activities and construction of the groin could directly and indirectly impact nesting females, their nests, and hatchling sea turtles when conducted between May 1 and November 15. The presence of the groin and future sand placement activities could directly and indirectly impact nesting females, their nests, and hatchling sea turtles for each subsequent nesting season within the Action Area.

Nature of the effect: The effects of the construction and presence of the groin and sand placement activities may change the nesting behavior of adult female sea turtles, diminish nesting success, and cause reduced hatching and emerging success. Sand placement can also change the incubation conditions within the nest. Any decrease in productivity and/or survival rates would contribute to the vulnerability of the sea turtles nesting in the southeastern United States.

The Service expects the action will result in direct and indirect, long-term effects to sea turtles, including the Northwest Atlantic DPS of the loggerhead sea turtle. Due to downdrift erosion, there may be loss or degradation of loggerhead terrestrial Critical Habitat Unit LOGG-T-NC-08. The Service expects there may be morphological changes to adjacent nesting habitat. Activities that affect or alter the use of optimal habitat or increase disturbance to the species may decrease the survival and recovery potential of the loggerhead and other sea turtles.

Duration: The construction of the groin is to be a one-time activity and may take 4 ½ months to complete. The sand placement activity is likely to be a multiple-year activity, and each sand placement project may take 10 weeks to complete. Thus, the direct effects would be expected to be short-term in duration. Indirect effects from the activity may continue to impact nesting and hatchling sea turtles and sea turtle nests in subsequent nesting seasons. In addition, the placement of the groin represents a long-term impact since the groin could be in place for many years.

Disturbance frequency: Sea turtle populations in the southeastern United States may experience decreased nesting success, hatching success, and hatchling emerging success that could result from the construction and sand placement activities being conducted during one nesting season, or during the earlier or later parts of one or two nesting seasons.

The frequency of maintenance dredging activities varies greatly, and can be as often as annually or semiannually, depending on the rate of shoaling and funding availability. Sand placement activities as a result of shore protection activities typically occur once every 3 to 5 years. For this project, sand placement is anticipated every 5 years. Dredging and sand placement typically occurs during the winter work window, but can occur at any time during the year based on availability of funding and of dredges to conduct the work. The disturbance frequency related to groin and jetty repair and replacement varies greatly based on the original construction methodology, the construction materials, and the conditions under which the structure is placed.

Disturbance intensity and severity: Depending on the timing of the construction and sand placement activities during the sea turtle nesting season, effects to the sea turtle populations in the southeastern United States could be important. The placement of the groin represents a long-term impact within the Action Area since the groin could be in place for many years.

2) Analyses for Effects of the Action

The Action Area encompasses 24,500 lf of shoreline on the Atlantic coast of North Carolina.

Beneficial Effects: Groins constructed in appropriate high erosion areas, or to offset the effects of shoreline armoring, may reestablish a beach where none currently exists, stabilize the beach in rapidly eroding areas and reduce the potential for escarpment formation, reduce destruction of nests from erosion, and reduce the need for future sand placement events by extending the interval between sand placement events. However, caution should be exercised to avoid automatically assuming the reestablishment of a beach will wholly benefit sea turtle populations without determining the extent of the groin effect on nesting and hatchling sea turtle behavior.

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

Direct Effects: Potential adverse effects during the project construction include disturbance of existing nests, which may have been missed by surveyors and thus not marked for avoidance, disturbance of females attempting to nest, and disorientation of emerging hatchlings. In addition, heavy equipment will be required to re-distribute the sand to the original natural beach template and to construct the groin. This equipment will have to traverse the beach portion of the Action Area, which could result in harm to nesting sea turtles, their nests, and emerging hatchlings. In addition, for groin construction, a trench will be excavated on the beach and may be present during the night for some portion of construction, creating a potential threat to nesting females and emerging hatchlings.

Following construction, the presence of the groin has the potential to adversely affect sea turtles. For instance, they may interfere with the egress and ingress of adult females at nesting sites; alter downdrift beach profiles through erosion, escarpment formation, and loss of berms; trap or obstruct hatchlings during a critical life-history stage; increase hatchling and adult female energy expenditure in attempts to overcome the structures; and attract additional predatory fish or concentrate existing predatory fish, thereby increasing the potential of hatchling predation.

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

a. *Equipment during construction*

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

The operation of motor vehicles or equipment on the beach to complete the project work at night affects sea turtle nesting by: interrupting or colliding with a nesting turtle on the beach, headlights disorienting or misorienting emergent hatchlings, vehicles running over hatchlings attempting to reach the ocean, and vehicle ruts on the beach interfering with hatchlings crawling to the ocean. Apparently, hatchlings become diverted not because they cannot physically climb out of a rut (Hughes and Caine 1994), but because the sides of the track cast a shadow and the hatchlings lose their line of sight to the ocean horizon (Mann 1977). The extended period of travel required to negotiate tire ruts may increase the susceptibility of hatchlings to dehydration and depredation during migration to the ocean (Hosier et al. 1981). Driving directly above or over incubating egg clutches or on the beach can cause sand compaction, which may result in adverse impacts on nest site selection, digging behavior, clutch viability, and emergence by hatchlings, as well as directly kill pre-emergent hatchlings (Mann 1977; Nelson and Dickerson 1987; Nelson 1988).

The physical changes and loss of plant cover caused by vehicles on vegetated areas or dunes can lead to various degrees of instability and cause dune migration. As vehicles move over the sand, sand is displaced downward, lowering the substrate. Since the vehicles also inhibit plant growth, and open the area to wind erosion, the beach and dunes may become unstable. Vehicular traffic on the beach or through dune breaches or low dunes may cause acceleration of overwash and erosion (Godfrey et al. 1978). Driving along the beachfront should be between the low and high tide water lines. To minimize the impacts to the beach, dunes, and dune vegetation, transport and access to the construction sites should be from the road to the maximum extent possible. However, if vehicular access to the beach is necessary, the areas for vehicle and equipment usage should be designated and marked.

b. *Artificial lighting as a result of an unnatural beach slope on the adjacent beach*

Visual cues are the primary sea-finding mechanism for hatchling sea turtles (Mrosovsky and Carr 1967; Mrosovsky and Shettleworth 1968; Dickerson and Nelson 1989; Witherington and Bjorndal 1991). When artificial lighting is present on or near the beach, it can misdirect hatchlings once they emerge from their nests and prevent them from reaching the ocean (Philibosian 1976; Mann 1977; FWC 2007). In addition, a significant reduction in sea turtle nesting activity has been documented on beaches illuminated with artificial lights (Witherington 1992). Therefore, construction lights along a project beach and on the dredging vessel may deter females from coming ashore to nest, misdirect females trying to return to the surf after a nesting event, and misdirect emergent hatchlings from adjacent non-project beaches.

The unnatural sloped beach adjacent to the structure exposes sea turtles and their nests to lights that were less visible, or not visible, from nesting areas before the sand placement activity, leading to a higher mortality of hatchlings. Review of over 10 years of empirical information from beach nourishment projects indicates that the number of sea turtles impacted by lights increases on the post-construction berm. A review of selected nourished beaches in Florida (South Brevard, North Brevard, Captiva Island, Ocean Ridge, Boca Raton, Town of Palm Beach, Longboat Key, and Bonita Beach) indicated disorientation reporting increased by approximately 300 percent the first nesting season after project construction and up to 542 percent the second year compared to pre-nourishment reports (Trindell et al. 2005).

Specific examples of increased lighting disorientations after a sand placement project include Brevard and Palm Beach Counties, Florida. A sand placement project in Brevard County, completed in 2002, showed an increase of 130 percent in disorientations in the nourished area. Disorientations on beaches in the County that were not nourished remained constant (Trindell 2007). This same result was also documented in 2003 when another beach in Brevard County was nourished and the disorientations increased by 480 percent (Trindell 2007). Installing appropriate beachfront lighting is the most effective method to decrease the number of disorientations on any developed beach including nourished beaches. A shoreline protection project was constructed at Ocean Ridge in Palm Beach County, Florida, between August 1997 and April 1998. Lighting disorientation events increased after nourishment. In spite of continued aggressive efforts to identify and correct lighting violations in 1998 and 1999, 86 percent of the disorientation reports were in the nourished area in 1998 and 66 percent of the reports were in the nourished area in 1999 (Howard and Davis 1999).

c. *Entrapment/physical obstruction*

Groins have the potential to interfere with the egress or ingress of adult females at nesting sites where they may proceed around them successfully, abort nesting for that night, or move to another section of beach to nest. This may cause an increase in energy expenditure, and, if the body of the groin is exposed, may act as a barrier between beach segments and also prevent nesting on the adjacent beach. In general, the groin is exposed to dissipate wave energy and facilitate sand bypass, functioning in many cases to stabilize the beach and adjacent areas.

Typically, sea turtles emerge from the nest at night when lower sand temperatures elicit an increase in hatchling activity (Witherington et al. 1990). After emergence, approximately 20 to 120 hatchlings crawl en *masse* immediately to the surf, using predominately visual cues to orient them (Witherington and Salmon 1992; Lohmann et al. 1997). Upon reaching the water, sea turtle hatchlings orient themselves into the waves and begin a period of hyperactive swimming activity, or swim frenzy, which lasts for approximately 24 hours (Salmon and Wyneken 1987; Wyneken et al. 1990; Witherington 1991). The swim frenzy effectively moves the hatchling quickly away from shallow, predator rich, nearshore waters to the relative safety of deeper water (Gyuris 1994; Wyneken et al. 2000). The first hour of a hatchling's life is precarious and predation is high, but threats decrease as hatchlings distance themselves from their natal beaches (Stancyk 1995; Pilcher et al. 2000). Delays in hatchling migration (both on the beach and in the water) can cause added expenditures of energy and an increase of time spent in predator rich nearshore waters. On rare occasions hatchlings will encounter natural nearshore features that are similar to the emergent structures proposed for this project. However, observations of hatchling behavior during an encounter with a sand bar at low tide, a natural shore-parallel barrier, showed the hatchlings maintained their shore-perpendicular path seaward, by crawling over the sand bar versus deviating from this path to swim around the sand bar through the trough, an easier alternative. In spite of the groin design features, the groin may adversely affect sea turtle hatchlings by serving as a barrier or obstruction to sea turtle hatchlings and delaying offshore migration; depleting or increasing expenditure of the "swim frenzy" energy critical for allowing hatchlings to reach the relative safety of offshore development areas; and possibly entrapping hatchlings within the groin or within eddies or other associated currents.

d. *Nest relocation*

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

In a 1994 Florida study comparing loggerhead hatching and emerging success of relocated nests with nests left in their original location, Moody (1998) found that hatching success was lower in relocated nests at nine of 12 beaches evaluated. In addition, emerging success was lower in relocated nests at 10 of 12 beaches surveyed in 1993 and 1994. Many of the direct effects of beach nourishment may persist over time. These direct effects include increased susceptibility of relocated nests to catastrophic events, the consequences of potential increased beachfront development, changes in the physical characteristics of the beach, the formation of escarpments, repair/replacement of groins and jetties, and future sand migration.

<u>*Indirect Effects*</u>: Many of the direct effects of a groin or beach nourishment may persist over time and become indirect impacts. These indirect effects include increased susceptibility of relocated nests to catastrophic events, the consequences of potential increased beachfront development, changes in the physical characteristics of the beach, the formation of escarpments, and future sand migration.

a. *Changes in the physical environment*

The presence of the groin may alter the natural coastal processes and result in an unnatural beach profiles resulting from the presence of groin, which could negatively impact sea turtles regardless of the timing of projects. The use of heavy machinery can cause sand compaction (Nelson et al. 1987; Nelson and Dickerson 1988a). Significant reductions in nesting success (i.e., false crawls occurred more frequently) have been documented on severely compacted beaches (Fletemeyer 1980; Raymond 1984; Nelson and Dickerson 1987; Nelson et al. 1987), and increased false crawls may result in increased physiological stress to nesting females.

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

Beach nourishment projects create an elevated, wider, and unnatural flat slope berm. Sea turtles nest closer to the water the first few years after nourishment because of the altered profile (and perhaps unnatural sediment grain size distribution) (Ernest and Martin 1999; Trindell 2005).

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

These impacts can be minimized by using suitable sand and by tilling (minimum depth of 36 inches) compacted sand after project completion. The level of compaction of a beach can be assessed by measuring sand compaction using a cone penetrometer (Nelson 1987). Tilling of a nourished beach with a root rake may reduce the sand compaction to levels comparable to unnourished beaches. However, a pilot study by Nelson and Dickerson (1988c) showed that a tilled nourished beach will remain uncompacted for only up to 1 year. Thus, multi-year beach compaction monitoring and, if necessary, tilling would help to ensure that project impacts on sea turtles are minimized.

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

b. *Escarpment formation*

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

c. *Increased susceptibility to catastrophic events*

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

d. *Increased beachfront development*

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

(National Research Council 1990a), and can also result in greater adverse effects due to artificial lighting, as discussed above.

e. *Future sand migration and erosion*

Groins and jetties are shore-perpendicular structures that are designed to trap sand that would otherwise be transported by longshore currents. Jetties are defined as structures placed to keep sand from flowing into channels (Kaufman and Pilkey 1979; Komar 1983). In preventing normal sand transport, these structures accrete updrift beaches while causing accelerated beach erosion downdrift of the structures (Komar 1983; Pilkey et al. 1984; National Research Council 1987), a process that results in degradation of sea turtle nesting habitat. As sand fills the area updrift from the groin or jetty, some littoral drift and sand deposition on adjacent downdrift beaches may occur due to spillover. However, these groins and jetties often force the stream of sand into deeper offshore water where it is lost from the system (Kaufman and Pilkey 1979). The greatest changes in beach profile near groins and jetties are observed close to the structures, but effects eventually may extend many miles along the coast (Komar 1983).

Jetties are placed at ocean inlets to keep transported sand from closing the inlet channel. Together, jetties and inlets are known to have profound effects on adjacent beaches (Kaufman and Pilkey 1979). Witherington et al. (2005) found a significant negative relationship between loggerhead nesting density and distance from the nearest of 17 ocean inlets on the Atlantic coast of Florida. The effect of inlets in lowering nesting density was observed both updrift and downdrift of the inlets, leading researchers to propose that beach instability from both erosion and accretion may discourage sea turtle nesting.

Erosion control structures (e.g., terminal groins, T-groins, and breakwaters), in conjunction with beach nourishment, can help stabilize U.S. Gulf and Atlantic coast barrier island beaches (Leonard et al. 1990). However, groins often result in accelerated beach erosion downdrift of the structures (Komar 1983; National Research Council 1987) and corresponding degradation of suitable sea turtle nesting habitat (NMFS and Service 1991; 1992). Initially, the greatest changes are observed close to the structures, but effects may eventually extend significant distances along the coast (Komar 1983).

Groins operate by blocking the natural longshore transport of littoral drift (Kaufman and Pilkey 1979; Komar 1983). Conventional rubble mound groins control erosion by trapping sand and dissipating some wave energy. In general, except for terminal groins at the downdrift limit of a littoral cell, groins are not considered favorable erosion control alternatives because they usually impart stability to the updrift beach and transfer erosion to the downdrift side of the structure. In addition, groins deflect longshore currents offshore, and excess sand builds up on the updrift side of the structure which may be carried offshore by those currents. This aggravates downdrift erosion and erosion escarpments are common on the downdrift side of groins (Humiston and Moore 2001).

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

f. *Erosion control structure breakdown*

If erosion control structures fail and break apart, the resulting debris may be spread upon the beach, which may further impede nesting females from accessing suitable nesting sites (resulting in a higher incidence of false crawls) and trap hatchlings and nesting turtles (NMFS and Service 1991; 1992; 1993).

3) Species' Response to a Proposed Action

The Service determined there is a potential for long-term adverse effects on sea turtles, particularly hatchlings, as a result of the presence of the groin. However, the Service acknowledges the potential benefits of the erosion control structure since it may minimize the effects of erosion on sea turtle nesting habitat and extend the sand placement interval. Nonetheless, an increase in sandy beach may not necessarily equate to an increase in suitable sea turtle nesting habitat.

The following summary illustrates sea turtle responses to and recovery from a nourishment project comprehensively studied by Ernest and Martin (1999). A significantly larger proportion of turtles emerging on nourished beaches abandoned their nesting attempts than turtles emerging on natural or pre-nourished beaches. This reduction in nesting success is most pronounced during the first year following project construction and is most likely the result of changes in physical beach characteristics associated with the nourishment project (e.g., beach profile, sediment grain size, beach compaction, frequency and extent of escarpments). During the first post-construction year, the time required for turtles to excavate an egg chamber on untilled, hard-packed sands increases significantly relative to natural conditions. However, tilling (minimum depth of 36 inches) is effective in reducing sediment compaction to levels that did not significantly prolong digging times. As natural processes reduced compaction levels on nourished beaches during the second post-construction year, digging times returned to natural levels (Ernest and Martin 1999).

During the first post-construction year, nests on nourished beaches are deposited significantly seaward of the toe of the dune and significantly landward of the tide line than nests on natural beaches. More nests are washed out on the wide, flat beaches of the nourished treatments than on the narrower steeply sloped natural beaches. This phenomenon may persist through the second post-construction year monitoring and result from the placement of nests near the seaward edge of the beach berm where dramatic profile changes, caused by erosion and scarping, occur as the beach equilibrates to a more natural contour.

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

D. Cumulative Effects

This project occurs on non-federal lands. Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion.

It is reasonable to expect continued shoreline stabilization, inlet dredging, and beach renourishment projects in this area in the future since erosion and sea-level rise increases would impact the existing beachfront development.

V. PIPING PLOVER

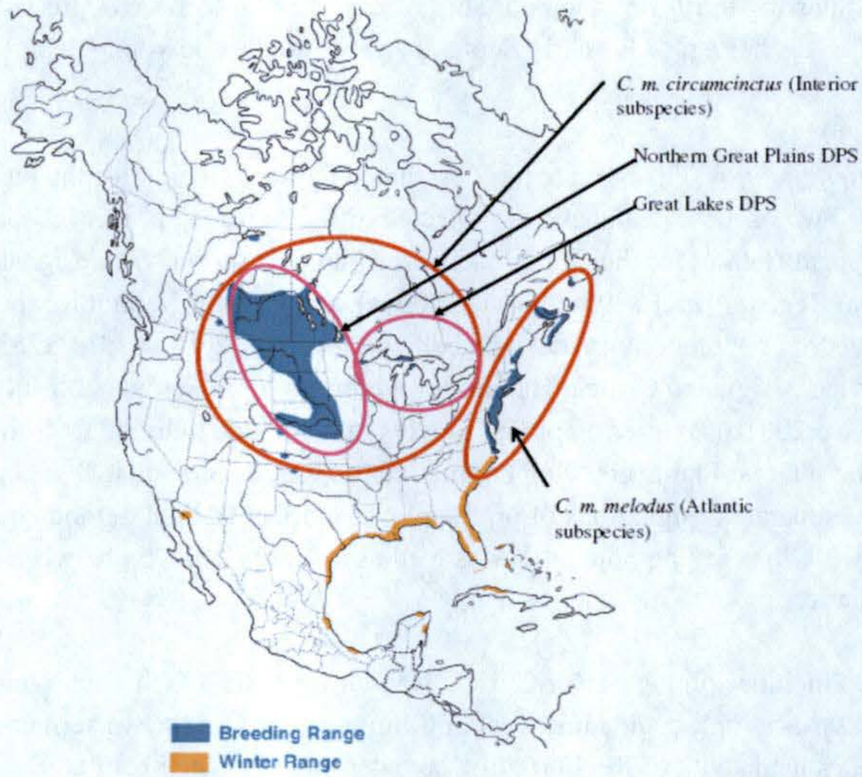
A. Status of the Species/Critical Habitat

1) Species/Critical Habitat Description

Listing: On January 10, 1986, the piping plover was listed as endangered in the Great Lakes watershed and threatened elsewhere within its range, including migratory routes outside of the Great Lakes watershed and wintering grounds (USFWS 1985). Piping plovers were listed principally because of habitat destruction and degradation, predation, and human disturbance. Protection of the species under the Act reflects the species' precarious status range-wide.

Three separate breeding populations have been identified, each with its own recovery criteria: the northern Great Plains (threatened), the Great Lakes (endangered), and the Atlantic Coast (threatened). Piping plovers that breed on the Atlantic Coast of the U.S. and Canada belong to the subspecies C. m. melodus. The second subspecies, C. m. circumcinctus, is comprised of two Distinct Population Segments (DPSs). One DPS breeds on the Northern Great Plains of the U.S. and Canada, while the other breeds on the Great Lakes. Each of these three entities is demographically independent. The Piping plover winters in coastal areas of the U.S. from North Carolina to Texas, and along the coast of eastern Mexico and on Caribbean islands from Barbados to Cuba and the Bahamas (Haig and Elliott-Smith 2004) (**Figure 2**).

Figure 2. Distribution and range of piping plovers (base map from Elliott-Smith and Haig 2004). Conceptual presentation of subspecies and DPS ranges are not intended to convey precise boundaries.



Piping plovers in the Action Area may include individuals from all three breeding populations. Piping plover subspecies are phenotypically indistinguishable, and most studies in the nonbreeding range report results without regard to breeding origin. Although a recent analysis shows strong patterns in the wintering distribution of piping plovers from different breeding populations, partitioning is not complete and major information gaps persist.

North Carolina is the only state where the piping plover's breeding and wintering ranges overlap and the birds are present year-round. Piping plovers nest above the high tide line on coastal beaches; on sand flats at the ends of sand spits and barrier islands; on gently sloping foredunes; in blowout areas behind primary dunes (overwashes); in sparsely vegetated dunes; and in overwash areas cut into or between dunes. The species requires broad, open, sand flats for feeding, and undisturbed flats with low dunes and sparse dune grasses for nesting. Piping plovers from the federally endangered Great Lakes population as well birds from the threatened populations of the Atlantic Coast and Northern Great Plains overwinter on North Carolina beaches. Piping plovers arrive on their breeding grounds in late March or early April. Following establishment of nesting territories and courtship rituals, the pair forms a depression in the sand, where the female lays her eggs. By early September both adults and young depart for their wintering areas.

Designated critical habitat: The Service has designated Critical Habitat for the piping plover on three occasions. Two of these designations protected different piping plover breeding populations. Critical Habitat for the Great Lakes breeding population was designated May 7, 2001 (66 Federal Register [FR] 22938; Service 2001a), and Critical Habitat for the northern Great Plains breeding population was designated September 11, 2002 (67 FR 57637; Service 2002). The Service designated Critical Habitat for wintering piping plovers on July 10, 2001 (66 FR 36038; Service 2001b). Wintering piping plovers may include individuals from the Great Lakes and northern Great Plains breeding populations as well as birds that nest along the Atlantic Coast. The three separate designations of piping plover Critical Habitat demonstrate diversity of PCEs between the two breeding populations as well as diversity of PCEs between breeding and wintering populations.

The Action Area includes piping plover Critical Habitat Unit NC-17 (Shallotte Inlet – Brunswick County). This 296-acre unit begins just west of Skimmer Court on the western end of Holden Beach. It includes land south of SR 1116, to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur to the MLLW along the Atlantic Ocean. It includes the contiguous shoreline from MLLW to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur along the Atlantic Ocean, Shallotte Inlet, and Intracoastal Waterway stopping north of Skimmer Court Road. The unnamed island and emergent sandbars to MLLW within Shallotte Inlet are also included.

The PCEs essential for the conservation of wintering piping plovers are those habitat components that support foraging, roosting, and sheltering and the physical features necessary for maintaining the natural processes that support these habitat components. The PCEs include intertidal beaches and flats (between annual low tide and annual high tide) and associated dune systems and flats above annual high tide. Important components of intertidal flats include sand and/or mud flats with no or very sparse emergent vegetation. In some cases, these flats may be covered or partially covered by a mat of blue-green algae. Adjacent non-or sparsely vegetated sand, mud, or algal flats above high tide are also important, especially for roosting piping plovers, and are PCEs of piping plover wintering habitat. Such sites may have debris, detritus (decaying organic matter), or micro-topographic relief (less than 50 cm above substrate surface) offering refuge from high winds and cold weather. Important components of the beach/dune ecosystem include surfcast algae, sparsely vegetated backbeach and salterns (beach area above mean high tide seaward of the permanent dune line, or in cases where no dunes exist, seaward of a delineating feature such as a vegetation line, structure, or road), spits, and washover areas. Washover areas are broad, unvegetated zones, with little or no topographic relief, that are formed and maintained by the action of hurricanes, storm surge, or other extreme wave action. Critical habitat does not include existing developed sites consisting of buildings, marinas, paved areas, boat ramps, exposed oil and gas pipelines and similar structures. Only those areas containing these PCEs within the designated boundaries are considered critical habitat.

The critical habitat in the project area has been relatively undisturbed since designation in 2001. It is unclear whether the Corps' dredging of Shallotte Inlet and/or the AIWW has resulted in impacts to the critical habitat unit. Although various other planning efforts have proposed dredging or nourishment within the critical habitat unit over the past decade, to the Service's knowledge, no destruction of critical habitat has occurred. As is expected in a dynamic inlet shoreline area, natural coastal processes have altered the location and configuration of the intertidal shoals and other PCEs within the unit. However, it does not appear that the general extent of critical habitat has been affected.

2) Life History

The piping plover is a small, pale sand-colored shorebird, about seven inches long with a wingspan of about 15 inches (Palmer 1967). Cryptic coloration is a primary defense mechanism for piping plovers where nests, adults, and chicks all blend in with their typical beach surroundings.

Piping plovers live an average of 5 years, although studies have documented birds as old as 11 (Wilcox 1959) and 15 years. Plovers are known to begin breeding as early as one year of age (MacIvor 1990; Haig 1992); however, the percentage of birds that breed in their first adult year is unknown. Piping plover breeding activity begins in mid-March when birds begin returning to their nesting areas (Coutu et al. 1990; Cross 1990; Goldin et al. 1990; MacIvor 1990; Hake 1993). Piping plovers generally fledge only a single brood per season, but may re-nest several times if previous nests are lost. The reduction in suitable nesting habitat due to a number of factors is a major threat to the species, likely limiting reproductive success and future recruitment into the population (USFWS 2009).

Plovers depart their breeding grounds for their wintering grounds between July and late August, but southward migration extends through November. More information about the three breeding populations of piping plovers can be found in the following documents:

a. Piping Plover, Atlantic Coast Population: 1996 Revised Recovery Plan (USFWS 1996a);
b. 2009 Piping Plover (*Charadrius melodus*) 5-Year Review: Summary and Evaluation (USFWS 2009);
c. 2003 Recovery Plan for the Great Lakes Piping Plover (*Charadrius melodus*) (USFWS 2003a);
d. Questions and Answers about the Northern Great Plains Population of Piping Plover (USFWS 2002).

North Carolina is one of the only states in which piping plovers may be found year-round. Piping plovers migrate through and winter in coastal areas of the U.S. from North Carolina to Texas and in portions of Mexico and the Caribbean. Data based on four rangewide mid-winter (late January to early February) population surveys, conducted at 5-year intervals starting in 1991, show that total numbers have fluctuated over time, with some areas experiencing increases and others decreases. Regional and local fluctuations may reflect the quantity and quality of suitable foraging and roosting habitat, which vary over time in response to natural coastal formation processes as well as anthropogenic habitat changes (e.g., inlet relocation, dredging of shoals and spits). Fluctuations may also represent localized weather conditions (especially wind) during surveys, or unequal survey coverage. Changes in wintering numbers may also be influenced by growth or decline in the particular breeding populations that concentrate their wintering distribution in a given area.

Gratto-Trevor et al. (2009) found strong patterns (but no exclusive partitioning) in winter distribution of uniquely banded piping plovers from four breeding populations. All eastern Canada and 94 percent of Great Lakes birds wintered from North Carolina to southwest Florida. However, eastern Canada birds were more heavily concentrated in North Carolina, and a larger proportion of Great Lakes piping plovers were found in South Carolina and Georgia. Northern Great Plains populations were primarily seen farther west and south, especially on the Texas Gulf Coast.

Breeding and wintering plovers feed on exposed wet sand in swash zones; intertidal ocean beach; wrack lines; washover passes; mud , sand , and algal flats; and shorelines of streams, ephemeral ponds, lagoons, and salt marshes by probing for invertebrates at or just below the surface (Coutu et al. 1990; USFWS 1996a). They use beaches adjacent to foraging areas for roosting and preening. Small sand dunes, debris, and sparse vegetation within adjacent beaches provide shelter from wind and extreme temperatures. Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging (Nicholls and Baldassarre 1990; Drake 1999a; 1999b). Studies have shown that the relative importance of various feeding habitat types may vary by site (Gibbs 1986; Coutu et al. 1990; McConnaughey et al. 1990; Loegering 1992; Goldin 1993; Hoopes 1993). Feeding activities may occur during all hours of the day and night (Staine and Burger 1994; Zonick 1997), and at all stages in the tidal cycle (Goldin 1993; Hoopes 1993). Wintering plovers primarily feed on invertebrates such as polychaete marine worms, various crustaceans, fly larvae, beetles, and occasionally bivalve mollusks found on top of the soil or just beneath the surface (Bent 1929; Cairns 1977; Nicholls 1989; Zonick and Ryan 1996).

Piping plovers exhibit a high degree of intra- and interannual wintering site fidelity (Nicholls and Baldassarre 1990; Drake et al. 2001; Noel and Chandler 2005; Stucker and Cuthbert 2006). However, local movements during winter are more common. In South Carolina, Maddock et al. (2009) documented many cross-inlet movements by wintering banded piping plovers as well as occasional movements of up to 11.2 miles by approximately 10 percent of the banded population. Larger movements within South Carolina were seen during fall and spring migration.

Atlantic Coast plovers nest on coastal beaches, sand flats at the ends of sand spits and barrier islands, gently-sloped foredunes, sparsely-vegetated dunes, and washover areas cut into or between dunes. Plovers arrive on the breeding grounds from mid-March through mid-May and remain for three to four months per year; the Atlantic Coast plover breeding activities begin in March in North Carolina with courtship and territorial establishment (Coutu et al., 1990; McConnaughey et al., 1990). Egg-laying begins around mid-April with nesting and brood rearing activities continuing through July. They lay three to four eggs in shallow scraped depressions lined with light colored pebbles and shell fragments. The eggs are well camouflaged and blend extremely well with their surroundings. Both sexes incubate the eggs which hatch within 30 days, and both sexes feed the young until they can fly. The fledgling period, the time between the hatching of the chicks and the point at which they can fly, generally lasts 25 to 35 days.

Atlantic Coast and Florida studies highlighted the importance of inlets for nonbreeding and breeding piping plovers. Almost 90 percent of roosting piping plovers at ten coastal sites in southwest Florida were on inlet shorelines (Lott et al. 2009b). Piping plovers were among seven shorebird species found more often than expected ($p = 0.0004$; Wilcoxon Test Scores) at inlet locations versus non-inlet locations in an evaluation of 361 International Shorebird Survey sites from North Carolina to Florida (Harrington 2008).

3) Population Dynamics

The International Piping Plover Breeding Census is conducted throughout the breeding grounds every 5 years by the Great Lakes/Northern Great Plains Recovery Team of the U.S. Geological Survey (USGS). The census is the largest known, complete avian species census. It is designed to determine species abundance and distribution throughout its annual cycle. The last survey in 2006 documented 3,497 breeding pairs, with a total of 8,065 birds throughout Canada and the U.S. (Elliot-Smith et al. 2009). A more recent 2010 Atlantic Coast breeding piping plover population estimate was 1,782 pairs, which was more than double the 1986 estimate of 790 pairs. This was determined to be a net increase of 86 percent between 1989 and 2010 (USFWS 2011). The 2006 International Piping Plover Census surveys documented 84 wintering piping plovers at 39 sites along approximately 344 km of North Carolina shoreline, and 87 breeding plovers at 29 sites along 338 km of shoreline (Elliott-Smith et al. 2009). Midwinter surveys may underestimate the abundance of nonbreeding piping plovers using a site or region during other months. In late September 2007, 104 piping plovers were counted at the south end of Ocracoke Island, North Carolina (National Park Service 2007), where none were seen during the 2006 International Piping Plover Winter Census (Elliott-Smith et al. 2009). Local movements of non-breeding piping plovers and number of surveyor visits to the site may also affect abundance estimates (Maddock et al. 2009; Cohen 2009).

The most consistent finding in the various population viability analyses conducted for piping plovers (Ryan et al. 1993; Melvin and Gibbs 1996; Plissner and Haig 2000; Wemmer et al. 2001; Larson et al. 2002; Amirault et al. 2005; Calvert et al. 2006; Brault 2007) indicates even small declines in adult and juvenile survival rates will cause increases in extinction risk. A banding study conducted between 1998 and 2004 in Atlantic Canada concluded lower return rates of juvenile (first year) birds to the breeding grounds than was documented for Massachusetts (Melvin and Gibbs 1996), Maryland (Loegering 1992), and Virginia (Cross 1996) breeding populations in the mid-1980s and very early 1990s. This is consistent with failure of the Atlantic Canada population to increase in abundance despite high productivity (relative to other breeding populations) and extremely low rates of dispersal to the U.S. over the last 15 plus years (Amirault et al. 2005). This suggests maximizing productivity does not ensure population increases. However, other studies suggest that survivability is good at wintering sites (Drake et al. 2001). Please see the Piping Plover 5-Year Review: Summary and Evaluation for additional information on survival rates at wintering habitats (USFWS 2009).

In 2001, 2,389 piping plovers were located during a winter census, accounting for only 40 percent of the known breeding birds recorded during a breeding census (Ferland and Haig 2002). About 89 percent of birds that are known to winter in the U.S. do so along the Gulf Coast (Texas to Florida), while 8 percent winter along the Atlantic Coast (North Carolina to Florida). The status of piping plovers on winter and migration grounds is difficult to assess, but threats to piping plover habitat used during winter and migration identified by the Service during its designation of Critical Habitat continue to affect the species. Unregulated motorized and pedestrian recreational use, inlet and shoreline stabilization projects, beach maintenance and nourishment, and pollution affect most winter and migration areas. Conservation efforts at some locations have likely resulted in the enhancement of wintering habitat.

Northern Great Plains Population

The Northern Great Plains plover breeds from Alberta to Manitoba, Canada and south to Nebraska; although some nesting has recently occurred in Oklahoma. Currently the most westerly breeding piping plovers in the United States occur in Montana and Colorado. The decline of piping plovers on rivers in the Northern Great Plains has been largely attributed to the loss of sandbar island habitat and forage base due to dam construction and operation. Nesting occurs on sand flats or bare shorelines of rivers and lakes, including sandbar islands in the upper Missouri River system, and patches of sand, gravel, or pebbly-mud on the alkali lakes of the northern Great Plains. Plovers do nest on shorelines of reservoirs created by the dams, but reproductive success is often low and reservoir habitat is not available in many years due to high water levels or vegetation. Dams operated with steady constant flows allow vegetation to grow on potential nesting islands, making these sites unsuitable for nesting. Population declines in alkali wetlands are attributed to wetland drainage, contaminants, and predation.

Since the Northern Great Plains population is geographically widespread, with many birds in very remote places, especially in the U.S. and Canadian alkali lakes. Thus, determining the number of birds or even identifying a clear trend in the population is a difficult task. The International Piping Plover Census (IPPC) was designed, in part, to help deal with this problem by instigating a large effort every five years in which an attempt is made to survey every area with known or potential piping plover breeding habitat during a two-week window (i.e., the first two weeks of June). The relatively short window is designed to minimize double counting if birds move from one area to another. The 1988 recovery plan uses the numbers from the IPPC as a major criterion for delisting, as does the 2006 Canadian Recovery Plan (Environment Canada 2006).

Participation in the IPPC has been excellent on the Northern Great Plains, with a tremendous effort put forth to attempt to survey areas during the census window (Elliot-Smith et al. 2009). The large area to be surveyed and sparse human population in the Northern Great Plains make annual surveys of the entire area impractical, so the IPPC provides an appropriate tool for helping to determine the population trend. Many areas are only surveyed during the IPPC years.

Figure 3 shows the number of adult plovers in the Northern Great Plains (U.S. and Canada) for the four International Censuses. The IPPC shows that the U.S. population decreased between 1991 and 1996, then increased in 2001 and 2006. The Canadian population showed the reverse trend for the first three censuses, increasing slightly as the U.S. population decreased, and then decreasing in 2001. Combined, the IPPC numbers suggest that the population declined from 1991 through 2001, then increased almost 58% between 2001 and 2006 (Elliott-Smith et al. 2009).

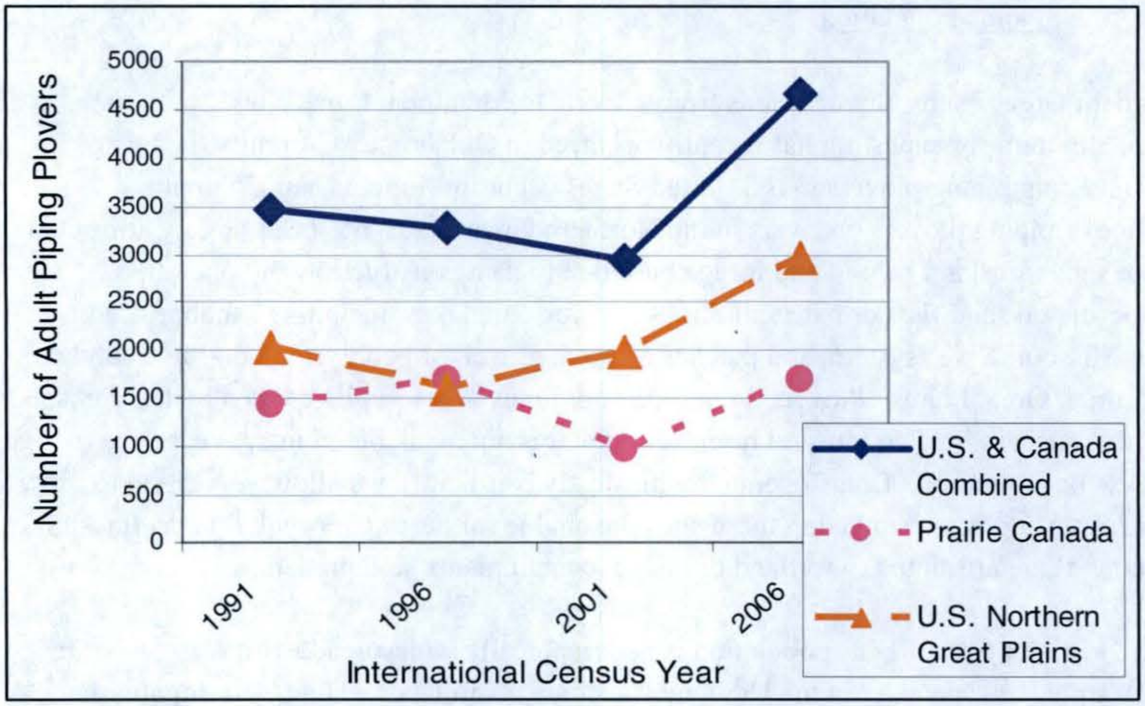


Figure 3. The number of adults reported for the U.S. and Canada Northern Great Plains during the International Censuses compared with the U.S. recovery goal.

The increase in 2006 is likely due in large part to a multi-year drought across the much of the region starting in 2001 that exposed thousands of acres of nesting habitat. The Corps ran low flows on the riverine stretches of the Missouri River for most of the years between censuses, allowing more habitat to be exposed and resulting in relatively high fledge ratios (USACE 2008a). The Corps also began to construct habitat using mechanical means (dredging sand from the riverbed) on the Missouri River in 2004, providing some new nesting and foraging habitat. The drought also caused reservoir levels to drop on many reservoirs throughout the Northern Great Plains (e.g. Missouri River Reservoirs (ND, SD), Lake McConaughey (NE)), providing shoreline habitat. The population increase may also be partially due to more intensive management activities on the alkali lakes, with increased management actions to improve habitat and reduce predation pressures.

While the IPPC provides an index to the piping plover population, the design does not always provide sufficient information to understand the population's dynamics. The five-year time interval between IPPC efforts may be too long to allow managers to get a clear picture of what the short-term population trends are and to respond accordingly if needed. As noted above, the first three IPPCs (1991, 1996, and 2001) showed a declining population, while the fourth (2006) indicated a dramatic population rebound of almost 58% for the combined U.S. and Canada Northern Great Plains population between 2001 and 2006. The preliminary results for 2011 indicate a similar grand population total as 2006, but a declining population in the United States (USFWS 2012). The larger overall population total in 2011 can be attributed to the larger numbers of plovers observed in the Bahamas. With only five data points over 20 years, it is impossible to determine if and to what extent the data reflects a real population trend versus error(s) in the 2011 census counts and/or a previous IPPC. The 2006 IPPC included a detectability component, in which a number of pre-selected sites were visited twice by the same observer(s) during the two-week window to get an estimate of error rate. This study found an approximately 76% detectability rate through the entire breeding area, with a range of between 39% to 78% detectability among habitat types in the Northern Great Plains. The results from the IPPC have been slow to be released, adding to the time lag between data collection and possible management response.

Great Lakes Population

The Great Lakes plovers once nested on Great Lakes beaches in Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, and Ontario. Great Lakes piping plovers nest on wide, flat, open, sandy or cobble shoreline with very little grass or other vegetation. Reproduction is adversely affected by human disturbance of nesting areas and predation by foxes, gulls, crows and other avian species. Shoreline development, such as the construction of marinas, breakwaters, and other navigation structures, has adversely affected nesting and brood rearing.

The Recovery Plan (USFWS 2003a) sets a population goal of at least 150 pairs (300 individuals), for at least 5 consecutive years, with at least 100 breeding pairs (200 individuals) in Michigan and 50 breeding pairs (100 individuals) distributed among sites in other Great Lakes states.

The Great Lakes piping plover population, which has been traditionally represented as the number of breeding pairs, has increased since the completion of the recovery plan in 2003 (Cuthbert and Roche 2007; 2006; Westbrock et al. 2005; Stucker and Cuthbert 2004; Stucker et al. 2003). The Great Lakes piping plover recovery plan documents the 2002 population at 51 breeding pairs (USFWS 2003a). The most recent census conducted in 2008 found 63 breeding pairs, an increase of approximately 23%. Of these, 53 pairs were found nesting in Michigan, while 10 were found outside the state, including six pairs in Wisconsin and four in Ontario, Canada. The 53 nesting pairs in Michigan represent approximately 50% of the recovery criterion. The 10 breeding pairs outside Michigan in the Great Lakes basin, represents 20% of the goal, albeit the number of breeding pairs outside Michigan has continued to increase over the past five years. The single breeding pair discovered in 2007 in the Great Lakes region of Canada represented the first confirmed piping plover nest there in over 30 years, and in 2008 the number of nesting pairs further increased to four.

In addition, the number of non-nesting individuals has increased annually since 2003. Between 2003-2008 an annual average of approximately 26 non-nesting piping plovers were observed, based on limited data from 2003, 2006, 2007, and 2008. Although there was some fluctuation in the total population between 2002-2008, the overall increase from 51 to 63 pairs combined with the increased observance of non-breeding individuals indicates the population is increasing. (**Figure 4**).

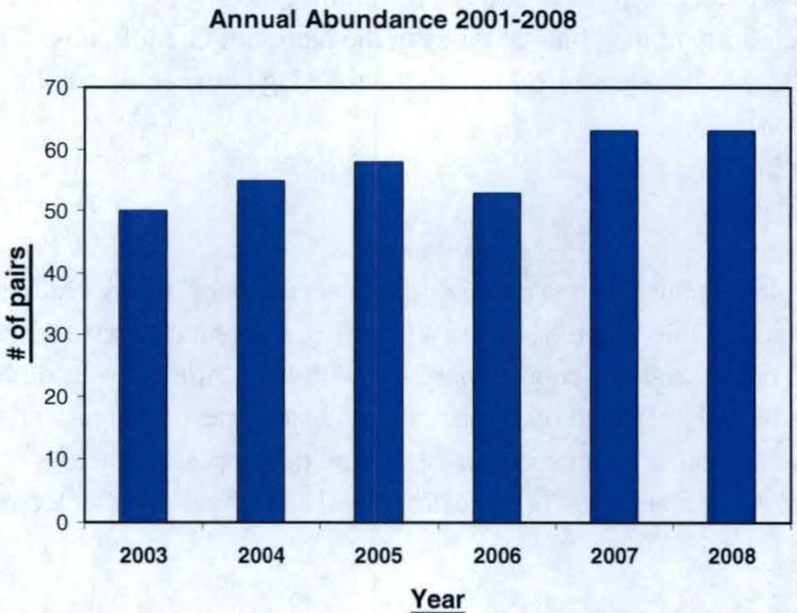


Figure 4. Annual Abundance Estimates for Great Lakes Piping Plovers (2003-2008).

Atlantic Coast Population

The Atlantic Coast piping plover breeds on coastal beaches from Newfoundland and southeastern Quebec to North Carolina. Historical population trends for the Atlantic Coast piping plover have been reconstructed from scattered, largely qualitative records. Nineteenth-century naturalists, such as Audubon and Wilson, described the piping plover as a common summer resident on Atlantic Coast beaches (Haig and Oring 1987). However, by the beginning of the 20th Century, egg collecting and uncontrolled hunting, primarily for the millinery trade, had greatly reduced the population, and in some areas along the Atlantic Coast, the piping plover was close to extirpation. Following passage of the Migratory Bird Treaty Act (40 Stat. 775; 16 U.S.C. 703-712) in 1918, and changes in the fashion industry that no longer exploited wild birds for feathers, piping plover numbers recovered to some extent (Haig and Oring 1985).

Available data suggest that the most recent population decline began in the late 1940s or early 1950s (Haig and Oring 1985). Reports of local or statewide declines between 1950 and 1985 are numerous, and many are summarized by Cairns and McLaren (1980) and Haig and Oring (1985). While Wilcox (1939) estimated more than 500 pairs of piping plovers on Long Island, New York, the 1989 population estimate was 191 pairs (see Table 4, USFWS 1996a). There was little focus on gathering quantitative data on piping plovers in Massachusetts through the late 1960s because the species was commonly observed and presumed to be secure. However, numbers of piping plover breeding pairs declined 50 to 100 percent at seven Massachusetts sites between the early 1970s and 1984 (Griffin and Melvin 1984). Piping plover surveys in the early years of the recovery effort found that counts of these cryptically colored birds sometimes went up with increased census effort, suggesting that some historic counts of piping plovers by one or a few observers may have underestimated the piping plover population. Thus, the magnitude of the species decline may have been more severe than available numbers imply.

Annual estimates of breeding pairs of Atlantic Coast piping plovers are based on multiple surveys at most occupied sites. Sites that cannot be monitored repeatedly in May and June (primarily sites with few pairs or inconsistent occupancy) are surveyed at least once during a standard nine-day count period (Hecht and Melvin 2009).

Since its 1986 listing under the ESA, the Atlantic Coast population estimate has increased 234%, from approximately 790 pairs to an estimated 1,849 pairs in 2008, and the U.S. portion of the population has almost tripled, from approximately 550 pairs to an estimated 1,596 pairs. Even discounting apparent increases in New York, New Jersey, and North Carolina between 1986 and 1989, which likely were due in part to increased census effort (USFWS 1996a), the population nearly doubled between 1989 and 2008. The largest population increase between 1989 and 2008 has occurred in New England (245%), followed by New York-New Jersey (74%). In the

Southern (DE-MD-VA-NC) Recovery Unit, overall growth between 1989 and 2008 was 66%, but almost three-quarters of this increase occurred in just two years, 2003-2005. The eastern Canada population fluctuated from year to year, with increases often quickly eroded in subsequent years; net growth between 1989 and 2008 was 9%.

The overall population growth pattern was tempered by periodic rapid declines in the Southern and Eastern Canada Recovery Units. The eastern Canada population decreased 21% in just three years (2002-2005), and the population in the southern half of the Southern Recovery Unit declined 68% in seven years (1995-2001). The recent 64% decline in the Maine population, from 66 pairs in 2002 to 24 pairs in 2008, following only a few years of decreased productivity, provides another example of the continuing risk of rapid and precipitous reversals in population growth.

4) Status and Distribution

Reason for Listing: Hunting during the 19th and early 20th centuries likely led to initial declines in the species; however, shooting piping plovers has been prohibited since 1918 pursuant to the provisions of the Migratory Bird Treaty Act (MBTA). Other human activities, such as habitat loss and degradation, disturbance from recreational pressure, contaminants, and predation are likely responsible for continued declines. These factors include development and shoreline stabilization. The 1985 final rule stated the number of piping plovers on the Gulf of Mexico coastal wintering grounds might be declining as indicated by preliminary analysis of the Christmas Bird Count data. Independent counts of piping plovers on the Alabama coast indicated a decline in numbers between the 1950s and early 1980s. At the time of listing, the Texas Parks and Wildlife Department stated 30 percent of wintering habitat in Texas had been lost over the previous 20 years. The final rule also stated, in addition to extensive breeding area problems, the loss and modification of wintering habitat was a significant threat to the piping plover.

Range-wide Trend: Five range-wide population surveys have been conducted for the piping plover; the 1991 (Haig and Plissner 1992), 1996 (Plissner and Haig 1997), 2001, 2006 (Elliott-Smith et al. 2009), and 2011 (USFWS 2012) International Piping Plover Censuses. These surveys were completed to help determine the species distribution and to monitor progress toward recovery.

Recovery Criteria

Delisting of the three piping plover populations may be considered when the following criteria are met:

Northern Great Plains Population (USFWS 1988; 1994)

1. Increase the number of birds in the U.S. northern Great Plains states to 2,300 pairs (USFWS 1994).
2. Increase the number of birds in the prairie region of Canada to 2,500 adult piping plovers (USFWS 1988).
3. Secure long term protection of essential breeding and wintering habitat (USFWS 1994).

Great Lakes Population (USFWS 2003a)

1. At least 150 pairs (300 individuals), for at least 5 consecutive years, with at least 100 breeding pairs (200 individuals) in Michigan and 50 breeding pairs (100 individuals) distributed among sites in other Great Lakes states.
2. Five-year average fecundity within the range of 1.5-2.0 fledglings per pair, per year, across the breeding distribution, and ten-year population projections indicate the population is stable or continuing to grow above the recovery goal.
3. Protection and long-term maintenance of essential breeding and wintering habitat is ensured, sufficient in quantity, quality, and distribution to support the recovery goal of 150 pairs (300 individuals).
4. Genetic diversity within the population is deemed adequate for population persistence and can be maintained over the long-term.
5. Agreements and funding mechanisms are in place for long-term protection and management activities in essential breeding and wintering habitat.

Atlantic Coast Population (USFWS 1996a)

1. Increase and maintain for 5 years a total of 2,000 breeding pairs, distributed among 4 recovery units.

Recovery Unit	*Minimum Subpopulation*
Atlantic (eastern) Canada	*400 pairs*
New England	*625 pairs*
New York-New Jersey	*575 pairs*
Southern (DE-MD-VA-NC)	*400 pairs*

2. Verify the adequacy of a 2,000 pair population of piping plovers to maintain heterozygosity and allelic diversity over the long term.
3. Achieve a 5-year average productivity of 1.5 fledged chicks per pair in each of the

4 recovery units described in criterion 1, based on data from sites that collectively support at least 90% of the recover unit's population.

4. Institute long-term agreements to assure protection and management sufficient to maintain the population targets and average productivity in each recovery unit.
5. Ensure long-term maintenance of wintering habitat, sufficient in quantity, quality, and distribution to maintain survival rates for a 2,000-pair population.

Breeding Range

<u>Northern Great Plains Population</u>

The IPPC numbers indicate that the Northern Great Plains population (including Canada) declined from 1991 through 2001, and then increased dramatically in 2006. This increase corresponded with a multi-year drought in the Missouri River basin that exposed a great deal of nesting habitat, suggesting that the population can respond fairly rapidly to changes in habitat quantity and quality. Despite this recent improvement, we do not consider the numeric, distributional, or temporal elements of the population recovery criteria achieved.

As the Missouri River basin emerges from drought and breeding habitat is inundated, the population will likely decline. The management activities carried out in many areas during drought conditions have undoubtedly helped to maintain and increase the piping plover population, especially to mitigate for otherwise poor reproductive success during wet years when habitat is limited.

While the population increase seen in recent years demonstrates the possibility that the population can rebound from low population numbers, ongoing efforts are needed to maintain and increase the population. In the U.S., piping plover crews attempt to locate most piping plover nests and take steps to improve their success. This work has suffered from insufficient and unstable funding in most areas.

Emerging threats, such as energy development (particularly wind, oil and gas and associated infrastructure) and climate change are likely to impact piping plovers both on the breeding and wintering grounds. The potential impact of both of these threats is not well understood, and measures to mitigate for them are also uncertain at this time.

In the recently completed status review, the Service concluded that the Northern Great Plains piping plover population remains vulnerable, especially due to management of river systems throughout the breeding range (USFWS 2009). Many of the threats identified in the 1988 recovery plan, including those affecting Northern Great Plains piping plover population during the two-thirds of its annual cycle spent in the wintering range, remain today or have intensified.

Great Lakes Population

The population has shown significant growth, from approximately 17 pairs at the time of listing in 1986, to 63 pairs in 2008. The total of 63 breeding pairs represents approximately 42% of the current recovery goal of 150 breeding pairs for the Great Lakes population. Productivity goals, as specified in the 2003 recovery plan, have been met over the past 5 years. During this time period the average annual fledging rate has been 1.76, well above the 1.5 fledglings per breeding pair recovery goal. A recent analysis of banded piping plovers in the Great Lakes, however, suggests that after hatch year survival (adult) rates may be declining. Continued population growth will require the long-term maintenance of productivity goals concurrent with measures to sustain or improve important vital rates.

Although initial information considered at the time of the 2003 recovery plan suggested the population may be at risk from a lack of genetic diversity, currently available information suggests that genetic diversity may not pose a high risk to the Great Lakes population. Additional genetic information is needed to assess genetic structure of the population and verify the adequacy of a 150 pair population to maintain long-term heterozygosity and allelic diversity.

Several years of population growth is evidence of the effectiveness of the ongoing Great Lakes piping plover recovery program. Most major threats, however, including habitat degradation, predation, and human disturbance remain persistent and pervasive. Severe threats from human disturbance and predation remain ubiquitous within the Great Lakes. Expensive labor-intensive management to minimize the effects of these continuing threats, as specified in recovery plan tasks, are implemented every year by a network of dedicated governmental and private partners. Because threats to Great Lakes piping plovers persist, reversal of gains in abundance and productivity are expected to quickly follow if current protection efforts are reduced.

Emerging potential threats to piping plovers in the Great Lakes basin include disease, wind turbine generators and, potentially, climate change. A recent out-break of Type E botulism in the Northern Lake Michigan basin resulted in several piping plover mortalities. Future outbreaks in areas that support a concentration of breeding piping plovers could impact survival rates and population abundance. Wind turbine projects, many of which are currently in the planning stages, need further study to determine potential risks to piping plovers and/or their habitat, as well as the need for specific protections to prevent or mitigate impacts. Climate change projections for the Great Lakes include the potential for significant water-level decreases.

The degree to which this factor will impact piping plover habitat is unknown, but prolonged water-level decreases are likely to alter habitat condition and distribution.

In the recently completed status review, the Service concluded that the Great Lakes population remains at considerable risk of extinction due to its small size, limited distribution and vulnerability to stochastic events, such as disease outbreak (USFWS 2009). In addition, the factors that led to the piping plover's 1986 listing remain present.

Atlantic Coast Population

Substantial population growth, from approximately 790 pairs in 1986 to an estimated 1,849 pairs in 2008, has decreased the Atlantic Coast piping plover's vulnerability to extinction since ESA listing. Thus, considerable progress has been made towards the overall goal of 2,000 breeding pairs articulated in recovery criterion 1. As discussed in the 1996 revised recovery plan, however, the overall security of the Atlantic Coast piping plover is fundamentally dependent on even distribution of population growth, as specified in subpopulation targets, to protect a sparsely-distributed species with strict biological requirements from environmental variation (including catastrophes) and increase the likelihood of interchange among subpopulations. Although the New England Recovery Unit has sustained its subpopulation target for the requisite five years, and the New York-New Jersey Recovery Unit reached its target in 2007 (but dipped below again in 2008), considerable additional growth is needed in the Southern and Eastern Canada Recovery Units (recovery criterion 1).

Productivity goals (criterion 3) specified in the 1996 recovery plan must be revised to accommodate new information about latitudinal variation in productivity needed to maintain a stationary population. Population growth, particularly in the three U.S. recovery units, provides indirect evidence that adequate productivity has occurred in at least some years. However, overall security of a 2,000 pair population will require long-term maintenance of these revised recovery-unit-specific productivity goals concurrent with population numbers at or above abundance goals.

Twenty years of relatively steady population growth, driven by productivity gains, also evidences the efficacy of the ongoing Atlantic Coast piping plover recovery program. However, all of the major threats (habitat loss and degradation, predation, human disturbance, and inadequacy of other (non-ESA) regulatory mechanisms) identified in the 1986 ESA listing and 1996 revised recovery plan remain persistent and pervasive. Indeed, recent information heightens the importance of conserving the low, sparsely vegetated beaches juxtaposed with abundant moist foraging substrates preferred by breeding Atlantic Coast piping plovers; development and artificial shoreline stabilization pose continuing widespread threats to this habitat. Severe threats from human disturbance and predation remain ubiquitous along the Atlantic Coast. Expensive labor-intensive management to minimize the effects of these continuing threats, as specified in recovery plan tasks, are implemented every year by a network of dedicated governmental and private cooperators. Because threats to Atlantic Coast piping plovers persist (and in many cases have increased since listing), reversal of gains in abundance and productivity would quickly follow diminishment of current protection efforts.

Finally, two emerging potential threats, wind turbine generators and climate change (especially sea-level rise) are likely to affect Atlantic Coast piping plovers throughout their life cycle. These two threats must be evaluated to ascertain their effects on piping plovers and/or their habitat, as well as the need for specific protections to prevent or mitigate impacts that could otherwise increase overall risks the species.

In the recently completed status review, the Service concluded that the Atlantic Coast piping plover remains vulnerable to low numbers in the Southern and Eastern Canada (and, to a lesser extent, the New York-New Jersey) Recovery Units (USFWS 2009). Furthermore, the factors that led to the piping plover's 1986 listing remain operative rangewide (including in New England), and many of these threats have increased. Interruption of costly, labor-intensive efforts to manage these threats would quickly lead to steep population declines.

Nonbreeding Range

Piping plovers spend up to 10 months of their life cycle on their migration and winter grounds, generally July 15 through as late as May 15. Piping plover migration routes and habitats overlap breeding and wintering habitats, and, unless banded, migrants passing through a site usually are indistinguishable from breeding or wintering piping plovers. Migration stopovers by banded piping plovers from the Great Lakes have been documented in New Jersey, Maryland, Virginia, and North Carolina (Stucker and Cuthbert 2006). Migrating breeders from eastern Canada have been observed in Massachusetts, New Jersey, New York, and North Carolina (Amirault et al. 2005). As many as 85 staging piping plovers have been tallied at various sites in the Atlantic breeding range (Perkins 2008 pers. communication), but the composition (e.g., adults that nested nearby and their fledged young of the year versus migrants moving to or from sites farther north), stopover duration, and local movements are unknown. In general, distance between stopover locations and duration of stopovers throughout the coastal migration range remains poorly understood.

Review of published records of piping plover sightings throughout North America by Pompei and Cuthbert (2004) found more than 3,400 fall and spring stopover records at 1,196 sites. Published reports indicated that piping plovers do not concentrate in large numbers at inland sites and that they seem to stop opportunistically. In most cases, reports of birds at inland sites were single individuals.

Piping plovers migrate through and winter in coastal areas of the U.S. from North Carolina to Texas and in portions of Mexico and the Caribbean. Gratto-Trevor et al. (2009) reported that six of 259 banded piping plovers observed more than once per winter moved across boundaries of the seven U.S. regions. This species exhibits a high degree of intra- and inter-annual wintering site fidelity (Nicholls and Baldassarre 1990; Drake et al. 2001; Noel et al. 2005; Stucker and Cuthbert 2006). Of 216 birds observed in different years, only eight changed regions between years, and several of these shifts were associated with late summer or early spring migration periods (Gratto-Trevor et al. 2009). Local movements are more common. In South Carolina, Maddock et al. (2009) documented many cross-inlet movements by wintering banded piping plovers as well as occasional movements of up to 18 km by approximately 10% of the banded population; larger movements within South Carolina were seen during fall and spring migration. Similarly, eight banded piping plovers that were observed in two locations during 2006-2007 surveys in Louisiana and Texas were all in close proximity to their original location, such as on the bay and ocean side of the same island or on adjoining islands (Maddock 2008).

Gratto-Trevor et al. (2009) found strong patterns (but no exclusive partitioning) in winter distribution of uniquely banded piping plovers from four breeding populations (**Figure 5**). All eastern Canada and 94% of Great Lakes birds wintered from North Carolina to southwest Florida. However, eastern Canada birds were more heavily concentrated in North Carolina, and a larger proportion of Great Lakes piping plovers were found in South Carolina and Georgia. Northern Great Plains populations were primarily seen farther west and south, especially on the Texas Gulf Coast. Although the great majority of Prairie Canada individuals were observed in Texas, particularly southern Texas, individuals from the U.S. Great Plains were more widely distributed on the Gulf Coast from Florida to Texas.

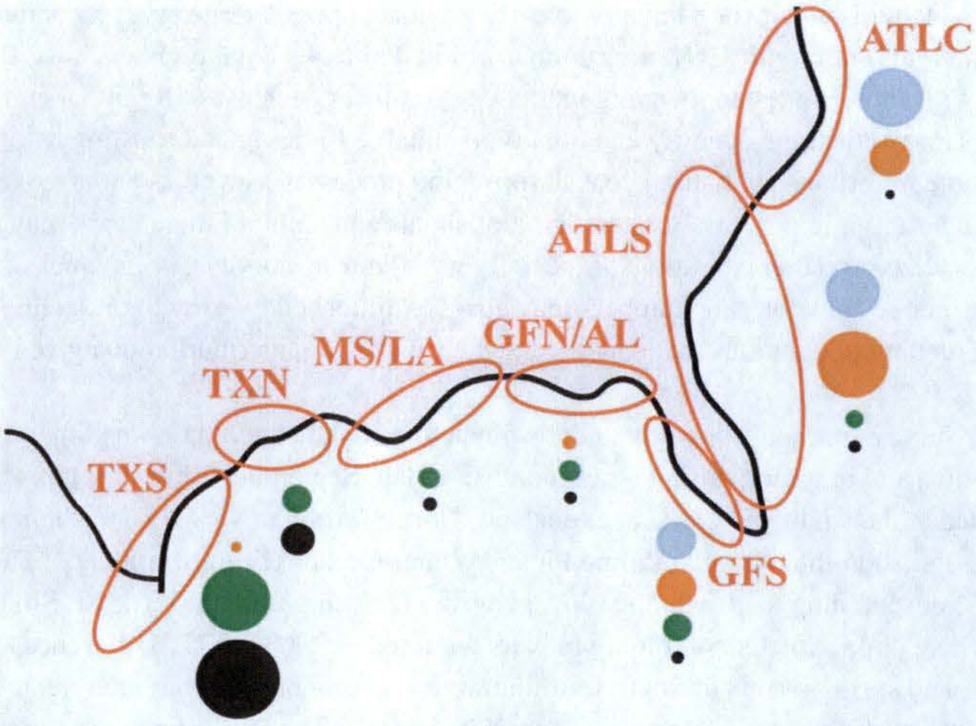


Figure 5. (from Gratto-Trevor et al. 2009, reproduced by permission). Breeding population distribution in the wintering/migration range. Regions: ATLC=Atlantic (eastern) Canada; GFS=Gulf Coast of southern Florida; GFN=Gulf Coast of north Florida; AL=Alabama; MS/LA=Mississippi and Louisiana; TXN=northern Texas; and TXS=southern Texas. For each breeding population, circles represent the percentage of individuals reported wintering along the eastern coast of the U.S. from the central Atlantic to southern Texas/Mexico up to December 2008. Each individual was counted only once. Grey circles represent Eastern Canada birds, Orange U.S. Great Lakes, Green U.S. Great Plains, and Black Prairie Canada. The relative size of the circle represents the percentage from a specific breeding area seen in that winter region. Total number of individuals observed on the wintering grounds was 46 for Eastern Canada, 150 for the U.S. Great Lakes, 169 for the U.S. Great Plains, and 356 for Prairie Canada.

The findings of Gratto-Trevor et al. (2009) provide evidence of differences in the wintering distribution of piping plovers from these four breeding areas. However, the distribution of birds by breeding origin during migration remains largely unknown. Other major information gaps include the wintering locations of the U.S. Atlantic Coast breeding population (banding of U.S. Atlantic Coast piping plovers has been extremely limited) and the breeding origin of piping plovers wintering on Caribbean islands and in much of Mexico. Banded piping plovers from the Great Lakes, Northern Great Plains, and eastern Canada breeding populations showed similar patterns of seasonal abundance at Little St. Simons Island, Georgia (Noel et al. 2007). However, the number of banded plovers originating from the latter two populations was relatively small at that study area.

Four rangewide mid-winter (late January to early February) population surveys, conducted at five-year intervals starting in 1991, are summarized in **Table 4**. Total numbers have fluctuated over time, with some areas experiencing increases and others decreases. Regional and local fluctuations may reflect the quantity and quality of suitable foraging and roosting habitat, which vary over time in response to natural coastal formation processes as well as anthropogenic habitat changes (e.g., inlet relocation, dredging of shoals and spits). Fluctuations may also represent localized weather conditions (especially wind) during surveys, or unequal survey coverage. Changes in wintering numbers may also be influenced by growth or decline in the particular breeding populations that concentrate their wintering distribution in a given area.

Mid-winter surveys may substantially underestimate the abundance of nonbreeding piping plovers using a site or region during other months. In late September 2007, 104 piping plovers were counted at the south end of Ocracoke Island, North Carolina (NPS 2007), where none were seen during the 2006 International Piping Plover Winter Census (Elliott-Smith et al. 2009). Noel et al. (2007) observed up to 100 piping plovers during peak migration at Little St. Simons Island, Georgia, where approximately 40 piping plovers wintered in 2003–2005. Differences among fall, winter, and spring counts in South Carolina were less pronounced, but inter-year fluctuations (e.g., 108 piping plovers in spring 2007 versus 174 piping plovers in spring 2008) at 28 sites were striking (Maddock et al. 2009). Even as far south as the Florida Panhandle, monthly counts at Phipps Preserve in Franklin County ranged from a mid-winter low of four piping plovers in December 2006 to peak counts of 47 in October 2006 and March 2007 (Smith 2007). Pinkston (2004) observed much heavier use of Texas Gulf Coast (ocean-facing) beaches between early September and mid-October (approximately 16 birds per mile) than during December to March (approximately two birds per mile).

Table 4. Results of the 1991, 1996, 2001, and 2006 International Piping Plover Winter Censuses (Haig et al. 2005; Elliott-Smith et al. 2009).

Location	**1991**	**1996**	**2001**	**2006**
Virginia	not surveyed (ns)	ns	ns	1
North Carolina	20	50	87	84
South Carolina	51	78	78	100
Georgia	37	124	111	212
Florida	**551**	**375**	**416**	**454**
-Atlantic	***70***	***31***	***111***	***133***
-Gulf	***481***	***344***	***305***	***321***
Alabama	12	31	30	29
Mississippi	59	27	18	78
Louisiana	750	398	511	226
Location	**1991**	**1996**	**2001**	**2006**
Texas	1,904	1,333	1,042	2,090
Puerto Rico	0	0	6	Ns
U.S. Total	**3,384**	**2,416**	**2,299**	**3,355**
Mexico	27	16	Ns	76
Bahamas	29	17	35	417
Cuba	11	66	55	89
Other Caribbean Islands	0	0	0	28
GRAND TOTAL	**3,451**	**2,515**	**2,389**	**3,884**
Percent of Total International Piping Plover Breeding Census	62.9%	42.4%	40.2%	48.2%

Local movements of nonbreeding piping plovers may also affect abundance estimates. At Deveaux Bank, one of South Carolina's most important piping plover sites, five counts at approximately 10-day intervals between August 27 and October 7, 2006, oscillated from 28 to 14 to 29 to 18 to 26 (Maddock et al. 2009). Noel and Chandler (2008) detected banded Great Lakes piping plovers known to be wintering on their Georgia study site in 73.8 ± 8.1 % of surveys over three years.

Abundance estimates for nonbreeding piping plovers may also be affected by the number of surveyor visits to the site. Preliminary analysis of detection rates by Maddock et al. (2009) found 87% detection during the mid-winter period on core sites surveyed three times a month during fall and spring and one time per month during winter, compared with 42% detection on sites surveyed three times per year (Cohen 2009 pers. communication).

The 2004 and 2005 hurricane seasons affected a substantial amount of habitat along the Gulf Coast. Habitats such as those along Gulf Islands National Seashore have benefited from increased washover events, which created optimal habitat conditions for piping plovers. Conversely, hard shoreline structures put into place following storms throughout the species range to prevent such shoreline migration prevent habitat creation (see *Factors Affecting Species Environment within the Action Area*). Four hurricanes between 2002 and 2005 are often cited in reference to rapid erosion of the Chandeleur Islands, a chain of low-lying islands in Louisiana where the 1991 International Piping Plover Census tallied more than 350 piping plovers. Comparison of imagery taken three years before and several days after Hurricane Katrina found that the Chandeleur Islands lost 82% of their surface area (Sallenger et al. 2009 in review), and a review of aerial photography prior to the 2006 Census suggested little piping plover habitat remained (Elliott-Smith et al. 2009). However, Sallenger et al. (2009 in review) noted that habitat changes in the Chandeleurs stem not only from the effects of these storms but rather from the combined effects of the storms, long-term (>1,000 years) diminishing sand supply, and sea-level rise relative to the land.

The Service is aware of the following site-specific conditions that benefit several habitats piping plover use while wintering and migrating, including critical habitat units. In Texas, one critical habitat unit was afforded greater protection due to the acquisition of adjacent upland properties by the local Audubon chapter. In another unit in Texas, vehicles were removed from a portion of the beach decreasing the likelihood of automobile disturbance to plovers. Exotic plant removal that threatens to invade suitable piping plover habitat is occurring in a critical habitat unit in South Florida. The Service and other government agencies remain in a contractual agreement with the USDA for predator control within limited coastal areas in the Florida panhandle, including portions of some critical habitat units. Continued removal of potential terrestrial predators is likely to enhance survivorship of wintering and migrating piping plovers. In North Carolina, one critical habitat unit was afforded greater protection when the local Audubon chapter agreed to manage the area specifically for piping plovers and other shorebirds following the relocation of the nearby inlet channel.

The status of piping plovers on winter and migration grounds is difficult to assess, but threats to piping plover habitat used during winter and migration identified by the Service during its designation of critical habitat continue to affect the species. Unregulated motorized and pedestrian recreational use, inlet and shoreline stabilization projects, beach maintenance and nourishment, and pollution affect most winter and migration areas. Conservation efforts at some locations have likely resulted the enhancement of wintering habitat.

Threats to Piping Plovers

The three recovery plans stated that shoreline development throughout the wintering range poses a threat to all populations of piping plovers. The plans further stated that beach maintenance and nourishment, inlet dredging, and artificial structures, such as jetties and groins, could eliminate wintering areas and alter sedimentation patterns leading to the loss of nearby habitat.

Important components of ecologically sound barrier beach management include perpetuation of natural dynamic coastal formation processes. Structural development along the shoreline or manipulation of natural inlets upsets the dynamic processes and results in habitat loss or degradation (Melvin et al. 1991). Throughout the range of migrating and wintering piping plovers, inlet and shoreline stabilization, inlet dredging, beach maintenance and nourishment activities, and seawall installations continue to constrain natural coastal processes. Dredging of inlets can affect spit formation adjacent to inlets and directly remove or affect ebb and flood tidal shoal formation. Jetties, which stabilize an island, cause island widening and subsequent growth of vegetation on inlet shores. Seawalls restrict natural island movement and exacerbate erosion. As discussed in more detail below, all these efforts result in loss of piping plover habitat. Construction of these projects during months when piping plovers are present also causes disturbance that disrupts the birds' foraging efficiency and hinders their ability to build fat reserves over the winter and in preparation for migration, as well as their recuperation from migratory flights. In addition, up to 24 shorebird species migrate or winter along the Atlantic Coast and almost 40 species of shorebirds are present during migration and wintering periods in the Gulf of Mexico region (Helmers 1992). Continual degradation and loss of habitats used by wintering and migrating shorebirds may cause an increase in intra-specific and inter-specific competition for remaining food supplies and roosting habitats. In Florida, for example, approximately 825 miles of coastline and parallel bayside flats (unspecified amount) were present prior to the advent of high human densities and beach stabilization projects. We estimate that only about 35% of the Florida coastline continues to support natural coastal formation processes, thereby concentrating foraging and roosting opportunities for all shorebird species and forcing some individuals into suboptimal habitats. Thus, intra- and inter-specific competition most likely exacerbates threats from habitat loss and degradation.

Sand placement projects

In the wake of episodic storm events, managers of lands under public, private, and county ownership often protect coastal structures using emergency storm berms; this is frequently followed by beach nourishment or renourishment activities (nourishment projects are considered "soft" stabilization versus "hard" stabilization such as seawalls). Berm placement and beach nourishment deposit substantial amounts of sand along Gulf of Mexico and Atlantic beaches to protect local property in anticipation of preventing erosion and what otherwise will be considered natural processes of overwash and island migration (Schmitt and Haines 2003).

Past and ongoing stabilization projects fundamentally alter the naturally dynamic coastal processes that create and maintain beach strand and bayside habitats, including those habitat components that piping plovers rely upon. Although impacts may vary depending on a range of factors, stabilization projects may directly degrade or destroy piping plover roosting and foraging habitat in several ways. Front beach habitat may be used to construct an artificial berm that is densely planted in grass, which can directly reduce the availability of roosting habitat. Over time, if the beach narrows due to erosion, additional roosting habitat between the berm and the water can be lost. Berms can also prevent or reduce the natural overwash that creates roosting habitats by converting vegetated areas to open sand areas. The vegetation growth caused by impeding natural overwash can also reduce the maintenance and creation of bayside intertidal feeding habitats. In addition, stabilization projects may indirectly encourage further development of coastal areas and increase the threat of disturbance.

At least 668 of 2,340 coastal shoreline miles (29% of beaches throughout the piping plover winter and migration range in the U.S.) are bermed, nourished, or renourished, generally for recreational purposes and to protect commercial and private infrastructure (**Table 5**). However, only approximately 54 miles or 2.31% of these impacts have occurred within critical habitat. In Louisiana, sediment placement projects are deemed environmental restoration projects by the Service, because without the sediment, many areas would erode below sea level.

Table 5. Summary of the extent of nourished beaches in piping plover wintering and migrating habitat within the conterminous U.S. From Service unpublished data (project files, gray literature, and field observations).

State	Sandy beach shoreline miles available	Sandy beach shoreline miles nourished to date (within critical habitat units)	Percent of sandy beach shoreline affected (within critical habitat units)
North Carolina	301[1]	117[5] (unknown)	39 (unknown)
South Carolina	187[1]	56 (0.6)	30 (0.32))
Georgia	100[1]	8 (0.4)	8 (0.40)
Florida	825[2]	404 (6)[6]	49 (0.72)
Alabama	53[1]	12 (2)	23 (3.77)
Mississippi	110[3]	$\geq$6 (0)	5 (0)
Louisiana	397[1]	Unquantified (usually restoration-oriented)	Unknown
Texas	367[4]	65 (45)	18 (12.26)
Overall Total	2,340 (does not include Louisiana)	$\geq$668 does not include Louisiana (54 in CH)	29% ($\geq$2.31% in CH)

Data from [1]www.50states.com; [2] Clark 1993; [3]N.Winstead, Mississippi Museum of Natural Science 2008; [4] www.Surfrider.org; [5] H. Hall, USFWS, pers. comm. 2009; [6] partial data from Lott et al. (2009a).

Inlet stabilization/relocation

Many navigable mainland or barrier island tidal inlets along the Atlantic and Gulf of Mexico coasts are stabilized with jetties, groins, or by seawalls and/or adjacent industrial or residential development. Jetties are structures built perpendicular to the shoreline that extend through the entire nearshore zone and past the breaker zone (Hayes and Michel 2008) to prevent or decrease sand deposition in the channel. Inlet stabilization with rock jetties and associated channel dredging for navigation alter the dynamics of longshore sediment transport and affect the location and movement rate of barrier islands (Camfield and Holmes 1995), typically causing downdrift erosion. Sediment is then dredged and added back to islands which subsequently widen. Once the island becomes stabilized, vegetation encroaches on the bayside habitat, thereby diminishing and eventually destroying its value to piping plovers. Accelerated erosion may compound future habitat loss, depending on the degree of sea-level rise. Unstabilized inlets naturally migrate, re-forming important habitat components, whereas jetties often trap sand and cause significant erosion of the downdrift shoreline. These combined actions affect the availability of piping plover habitat (Cohen et al. 2008).

Using Google Earth© (accessed April 2009), Service's biologists visually estimated the number of navigable mainland or barrier island tidal inlets throughout the wintering range of the piping plover in the conterminous U.S. that have some form of hardened structure. This includes seawalls or adjacent development, which lock the inlets in place (**Table 6**).

Table 6. Number of hardened inlets by state. Asterisk (*) represents an inlet at the state line, in which case half an inlet is counted in each state.

State	**Visually estimated number of navigable mainland and barrier island inlets per state**	**Number of hardened inlets**	**% of inlets affected**
North Carolina	20	2.5*	12.5%
South Carolina	34	3.5*	10.3%
Georgia	26	2	7.7%
Florida	82	41	50%
Alabama	14	6	42.9%
Mississippi	16	7	43.8%
Louisiana	40	9	22.5%
Texas	17	10	58.8%
Overall Total	249	81	32.5%

Tidal inlet relocation can cause loss and/or degradation of piping plover habitat; although less permanent than construction of hard structures, effects can persist for years. Service biologists are aware of at least seven inlet relocation projects (two in North Carolina, three in South Carolina, two in Florida), but this number likely under-represents the extent of this activity.

Sand mining/dredging

Sand mining, the practice of extracting (dredging) sand from sand bars, shoals, and inlets in the nearshore zone, is a less expensive source of sand than obtaining sand from offshore shoals for beach nourishment. Sand bars and shoals are sand sources that move onshore over time and act as natural breakwaters. Inlet dredging reduces the formation of exposed ebb and flood tidal shoals considered to be primary or optimal piping plover roosting and foraging habitat. Removing these sand sources can alter depth contours and change wave refraction as well as cause localized erosion (Hayes and Michel 2008). Exposed shoals and sandbars are also valuable to piping plovers, as they tend to receive less human recreational use (because they are only accessible by boat) and therefore provide relatively less disturbed habitats for birds. We do not have a good estimate of the amount of sand mining that occurs across the piping plover wintering range, nor do we have a good estimate of the number of inlet dredging projects that occur. Most jettied inlets need maintenance dredging, but non-hardened inlets are often dredged as well.

*Groin*s

Groins (structures made of concrete, rip rap, wood, or metal built perpendicular to the beach in order to trap sand) are typically found on developed beaches with severe erosion. Although groins can be individual structures, they are often clustered along the shoreline. Groins can act as barriers to longshore sand transport and cause downdrift erosion (Hayes and Michel 2008), which prevents piping plover habitat creation by limiting sediment deposition and accretion. These structures are found throughout the southeastern Atlantic Coast, and although most were in place prior to the piping plover's 1986 ESA listing, installation of new groins continues to occur.

Seawalls and revetments

Seawalls and revetments are vertical hard structures built parallel to the beach in front of buildings, roads, and other facilities to protect them from erosion. However, these structures often accelerate erosion by causing scouring in front of and downdrift from the structure (Hayes and Michel 2008), which can eliminate intertidal foraging habitat and adjacent roosting habitat. Physical characteristics that determine microhabitats and biological communities can be altered after installation of a seawall or revetment, thereby depleting or changing composition of benthic communities that serve as the prey base for piping plovers. At four California study sites, each comprised of an unarmored segment and a segment seaward of a seawall, Dugan and Hubbard (2006) found that armored segments had narrower intertidal zones, smaller standing crops of macrophyte wrack, and lower shorebird abundance and species richness. Geotubes (long cylindrical bags made of high-strength permeable fabric and filled with sand) are softer alternatives, but act as barriers by preventing overwash. We did not find any sources that summarize the linear extent of seawall, revetment, and geotube installation projects that have occurred across the piping plover's wintering and migration habitat.

Exotic/invasive vegetation

A recently identified threat to piping plover habitat, not described in the listing rule or recovery plans, is the spread of coastal invasive plants into suitable piping plover habitat. Like most invasive species, coastal exotic plants reproduce and spread quickly and exhibit dense growth habits, often outcompeting native plant species. If left uncontrolled, invasive plants cause a habitat shift from open or sparsely vegetated sand to dense vegetation, resulting in the loss or degradation of piping plover roosting habitat, which is especially important during high tides and migration periods.

Beach vitex (*Vitex rotundifolia*) is a woody vine introduced into the southeastern U.S. as a dune stabilization and ornamental plant (Westbrooks and Madsen 2006). It currently occupies a very small percentage of its potential range in the U.S.; however, it is expected to grow well in coastal communities throughout the southeastern U.S. from Virginia to Florida, and west to Texas (Westbrooks and Madsen 2006). In 2003, the plant was documented in New Hanover, Pender, and Onslow counties in North Carolina, and at 125 sites in Horry, Georgetown, and Charleston counties in South Carolina. Beach vitex has been documented from two locations in northwest Florida, but one site disappeared after erosional storm events. The landowner of the other site has indicated an intention to eradicate the plant, but follow through is unknown (Farley 2009 pers. communication). Task forces formed in North and South Carolina in 2004-05 have made great strides to remove this plant from their coasts. To date, about 200 sites in North Carolina have been treated, with 200 additional sites in need of treatment. Similar efforts are underway in South Carolina.

Unquantified amounts of crowfootgrass (*Dactyloctenium aegyptium*) grow invasively along portions of the Florida coastline. It forms thick bunches or mats that may change the vegetative structure of coastal plant communities and alter shorebird habitat.

The Australian pine (*Casuarina equisetifolia*) changes the vegetative structure of the coastal community in south Florida and islands within the Bahamas. Shorebirds prefer foraging in open areas where they are able to see potential predators, and tall trees provide good perches for avian predators. Australian pines potentially impact shorebirds, including the piping plover, by reducing attractiveness of foraging habitat and/or increasing avian predation. The propensity of these exotic species to spread, and their tenacity once established, make them a persistent threat, partially countered by increasing landowner awareness and willingness to undertake eradication activities.

Wrack removal and beach cleaning

Wrack on beaches and baysides provides important foraging and roosting habitat for piping plovers (Drake 1999a; Smith 2007; Maddock et al. 2009; Lott et al. 2009b; and many other shorebirds on their winter, breeding, and migration grounds. Because shorebird numbers are positively correlated with wrack cover and biomass of their invertebrate prey that feed on wrack (Tarr and Tarr 1987; Hubbard and Dugan 2003; Dugan et al. 2003), grooming will lower bird numbers (Defreo et al. 2009).

There is increasing popularity in the Southeast, especially in Florida, for beach communities to carry out "beach cleaning" and "beach raking" actions. Beach cleaning occurs on private beaches, where piping plover use is not well documented, and on some municipal or county beaches that are used by piping plovers. Most wrack removal on state and federal lands is limited to post-storm cleanup and does not occur regularly.

Man-made beach cleaning and raking machines effectively remove seaweed, fish, glass, syringes, plastic, cans, cigarettes, shells, stone, wood, and virtually any unwanted debris (Barber Beach Cleaning Equipment 2009). These efforts remove accumulated wrack, topographic depressions, and sparse vegetation nodes used by roosting and foraging piping plovers. Removal of wrack also eliminates a beach's natural sand-trapping abilities, further destabilizing the beach. In addition, sand adhering to seaweed and trapped in the cracks and crevices of wrack is removed from the beach. Although the amount of sand lost due to single sweeping actions may be small, it adds up considerably over a period of years (Nordstrom et al. 2006; Neal et al. 2007). Beach cleaning or grooming can result in abnormally broad unvegetated zones that are inhospitable to dune formation or plant colonization, thereby enhancing the likelihood of erosion (Defreo et al. 2009).

Predation

The 1996 Atlantic Coast Recovery Plan summarized evidence that human activities affect types, numbers, and activity patterns of some predators, thereby exacerbating natural predation on breeding piping plovers. The impact of predation on migrating or wintering piping plovers remains largely undocumented.

Recreational disturbance

Intense human disturbance in shorebird winter habitat can be functionally equivalent to habitat loss if the disturbance prevents birds from using an area (Goss-Custard et al. 1996), which can lead to roost abandonment and local population declines (Burton et al. 1996). Pfister et al.

(1992) implicate anthropogenic disturbance as a factor in the long-term decline of migrating shorebirds at staging areas. Disturbance, i.e., human and pet presence that alters bird behavior, disrupts piping plovers as well as other shorebird species. Disturbance can cause shorebirds to spend less time roosting or foraging and more time in alert postures or fleeing from the disturbances (Johnson and Baldassarre 1988; Burger 1991; Burger 1994; Elliott and Teas 1996; Lafferty 2001a, 2001b; Thomas et al. 2002), which limits the local abundance of piping plovers (Zonick and Ryan 1995; Zonick 2000). Shorebirds that are repeatedly flushed in response to disturbance expend energy on costly short flights (Nudds and Bryant 2000).

Shorebirds are more likely to flush from the presence of dogs than people, and birds react to dogs from farther distances than people (Lafferty 2001a; 2001b; Thomas et al. 2002). Dogs off leash are more likely to flush piping plovers from farther distances than are dogs on leash; nonetheless, dogs both on and off leashes disturb piping plovers (Hoopes 1993). Pedestrians walking with dogs often go through flocks of foraging and roosting shorebirds; some even encourage their dogs to chase birds.

Off-road vehicles can significantly degrade piping plover habitat (Wheeler 1979) or disrupt the birds' normal behavior patterns (Zonick 2000). The 1996 Atlantic Coast recovery plan cites tire ruts crushing wrack into the sand, making it unavailable as cover or as foraging substrate (Hoopes 1993; Goldin 1993). The plan also notes that the magnitude of the threat from off-road vehicles is particularly significant, because vehicles extend impacts to remote stretches of beach where human disturbance will otherwise be very slight. Godfrey et al. (1980 as cited *in* Lamont et al. 1997) postulated that vehicular traffic along the beach may compact the substrate and kill marine invertebrates that are food for the piping plover. Zonick (2000) found that the density of off-road vehicles negatively correlated with abundance of roosting piping plovers on the ocean beach. Cohen et al. (2008) found that radio-tagged piping plovers using ocean beach habitat at Oregon Inlet in North Carolina were far less likely to use the north side of the inlet where off-road vehicle use is allowed, and recommended controlled management experiments to determine if recreational disturbance drives roost site selection. Ninety-six percent of piping plover detections were on the south side of the inlet even though it was farther away from foraging sites (1.8 km from the sound side foraging site to the north side of the inlet versus 0.4 km from the sound side foraging site to the north side of the inlet; Cohen et al. 2008).

Based on surveys with land managers and biologists, knowledge of local site conditions, and other information, we have estimated the levels of eight types of disturbance at sites in the U.S. with wintering piping plovers. There are few areas used by wintering piping plovers that are devoid of human presence, and just under half have leashed and unleashed dog presence (Smith 2007; Lott et al. 2009b; Service unpubl. data 2009; Maddock and Bimbi unpubl. data).

Table 7 summarizes the disturbance analysis results. Data are not available on human disturbance at wintering sites in the Bahamas, other Caribbean countries, or Mexico.

Table 7. Percent of known piping plover winter and migration habitat locations, by state, where various types of anthropogenic disturbance have been reported.

	Percent by State							
Disturbance Type	**AL**	**FL**	**GA**	**LA**	**MS**	**NC**	**SC**	**TX**
Pedestrians	67	92	94	25	100	100	88	54
Dogs on leash	67	69	31	25	73	94	25	25
Dogs off leash	67	81	19	25	73	94	66	46
Bikes	0	19	63	25	0	0	28	19
ATVs	0	35	0	25	0	17	25	30
ORVs	0	21	0	25	0	50	31	38
Boats	33	65	100	100	0	78	63	44
Kite surfing	0	10	0	0	0	33	0	0

Although the timing, frequency, and duration of human and dog presence throughout the wintering range are unknown, studies in Alabama and South Carolina suggest that most disturbances to piping plovers occurs during periods of warmer weather, which coincides with piping plover migration (Johnson and Baldassarre 1988; Lott et al. 2009b; Maddock et al. 2009). Smith (2007) documents varying disturbance levels throughout the nonbreeding season at northwest Florida sites.

LeDee (2008) collected survey responses in 2007 from 35 managers (located in seven states) at sites that were designated as critical habitat for wintering piping plovers. Ownership included federal, state, and local governmental agencies and non-governmental organizations managing national wildlife refuges; national, state, county, and municipal parks; state and estuarine research reserves; state preserves; state wildlife management areas; and other types of managed lands. Of 44 reporting sites, 40 allowed public beach access year-round and four sites were closed to the public. Of the 40 sites that allow public access, 62% of site managers reported >10,000 visitors during September-March, and 31% reported >100,000 visitors. Restrictions on visitor activities on the beach included automobiles (at 81% of sites), all-terrain vehicles (89%), and dogs during the winter season (50%). Half of the survey respondents reported funding as a primary limitation in managing piping plovers and other threatened and endangered species at their sites. Other limitations included "human resource capacity" (24%), conflicting management priorities (12%), and lack of research (3%).

Disturbance can be addressed by implementing recreational management techniques such as vehicle and pet restrictions and symbolic fencing (usually sign posts and string) of roosting and feeding habitats. In implementing conservation measures, managers need to consider a range of site-specific factors, including the extent and quality of roosting and feeding habitats and the types and intensity of recreational use patterns. In addition, educational materials such as informational signs or brochures can provide valuable information so that the public understands the need for conservation measures.

In sum, although there is some variability among states, disturbance from human beach recreation and pets poses a moderate to high and escalating threat to migrating and wintering piping plovers. Systematic review of recreation policy and beach management across the nonbreeding range will assist in better understanding cumulative impacts. Site-specific analysis and implementation of conservation measures should be a high priority at piping plover sites that have moderate or high levels of disturbance and the Service and state wildlife agencies should increase technical assistance to land managers to implement management strategies and monitor their effectiveness.

Climate Change (sea-level rise)

Over the past 100 years, the globally-averaged sea level has risen approximately 10-25 centimeters (Rahmstorf et al. 2007), a rate that is an order of magnitude greater than that seen in the past several thousand years (Douglas et al. 2001 as cited in Hopkinson et al. 2008). The IPCC suggests that by 2080 sea-level rise could convert as much as 33% of the world's coastal wetlands to open water (IPCC 2007). Although rapid changes in sea level are predicted, estimated time frames and resulting water levels vary due to the uncertainty about global temperature projections and the rate of ice sheets melting and slipping into the ocean (IPCC 2007; CCSP 2008).

Potential effects of sea-level rise on coastal beaches may vary regionally due to subsidence or uplift as well as the geological character of the coast and nearshore (CCSP 2009; Galbraith et al. 2002). In the last century, for example, sea-level rise along the U.S. Gulf Coast exceeded the global average, and averages as high as 0.32 inches per year, because those areas are subsiding (USEPA 2014). Sediment compaction and oil and gas extraction compound tectonic subsidence (Penland and Ramsey 1990; Morton et al. 2003; Hopkinson et al. 2008). Low elevations and proximity to the coast make all nonbreeding coastal piping plover foraging and roosting habitats vulnerable to the effects of rising sea level. Sea-level rise was cited as a contributing factor in the 68% decline in tidal flats and algal mats in the Corpus Christi area (i.e., Lamar Peninsula to Encinal Peninsula) in Texas between the 1950s and 2004 (Tremblay et al. 2008). Mapping by Titus and Richman (2001) showed that more than 80% of the lowest land along the Atlantic and

Gulf coasts was in Louisiana, Florida, Texas, and North Carolina, where 73.5% of all wintering piping plovers were tallied during the 2006 International Piping Plover Census (Elliott-Smith et al. 2009).

Inundation of piping plover habitat by rising seas could lead to permanent loss of habitat if natural coastal dynamics are impeded by numerous structures or roads, especially if those shorelines are also armored with hardened structures. Without development or armoring, low undeveloped islands can migrate toward the mainland, pushed by the overwashing of sand eroding from the seaward side and being re-deposited in the bay (Scavia et al. 2002). Overwash and sand migration are impeded on developed portions of islands. Instead, as sea-level increases, the ocean-facing beach erodes and the resulting sand is deposited offshore. The buildings and the sand dunes then prevent sand from washing back toward the lagoons, and the lagoon side becomes increasingly submerged during extreme high tides (Scavia et al. 2002), diminishing both barrier beach shorebird habitat and protection for mainland developments.

Modeling for three sea-level rise scenarios (reflecting variable projections of global temperature rise) at five important U.S. shorebird staging and wintering sites predicted loss of 20-70% of current intertidal foraging habitat (Galbraith et al. 2002). These authors estimated probabilistic sea-level changes for specific sites partially based on historical rates of sea-level change (from tide gauges at or near each site); they then superimposed this on projected 50% and 5% probability of global sea-level changes by 2100 of 34 cm and 77 cm, respectively. The 50% and 5% probability sea level change projections were based on assumed global temperature increases of 2° C (50% probability) and 4.7° C (5% probability). The most severe losses were projected at sites where the coastline is unable to move inland due to steep topography or seawalls. The Galbraith et al. (2002) Gulf Coast study site, Bolivar Flats, Texas, is a designated critical habitat unit known to host high numbers of piping plovers during migration and throughout the winter; e.g., 275 individuals were tallied during the 2006 International Piping Plover Census (Elliott-Smith et al. 2009). Under the 50% likelihood scenario for sea-level rise, Galbraith et al. (2002) projected approximately 38% loss of intertidal flats at Bolivar Flats by 2050; however, after initially losing habitat, the area of tidal flat habitat was predicted to slightly increase by the year 2100, because Bolivar Flats lacks armoring, and the coastline at this site can thus migrate inland. Although habitat losses in some areas are likely to be offset by gains in other locations, Galbraith et al. (2002) noted that time lags may exert serious adverse effects on shorebird populations. Furthermore, even if piping plovers are able to move their wintering locations in response to accelerated habitat changes, there could be adverse effects on the birds' survival rates or reproductive fitness.

Table 8 displays the potential for adjacent development and/or hardened shorelines to impede response of habitat to sea-level rise in the eight states supporting wintering piping plovers.

Although complete linear shoreline estimates are not readily obtainable, almost all known piping plover wintering sites in the U.S. were surveyed during the 2006 International Piping Plover Census. To estimate effects at the census sites, as well as additional areas where piping plovers have been found outside of the census period, Service biologists reviewed satellite imagery and spoke with other biologists familiar with the sites. Of 406 sites, 204 (50%) have adjacent structures that may prevent the creation of new habitat if existing habitat were to become inundated. These threats will be perpetuated in places where damaged structures are repaired and replaced, and exacerbated where the height and strength of structures are increased. Data do not exist on the amount or types of hardened structures at wintering sites in the Bahamas, other Caribbean countries, or Mexico.

Table 8. Number of sites surveyed during the 2006 winter International Piping Plover Census with hardened or developed structures adjacent to the shoreline.

State	**Number of sites surveyed during the 2006 winter Census**	**Number of sites with some armoring or development**	**Percent of sites affected**
North Carolina	37 (+2)*	20	51
South Carolina	39	18	46
Georgia	13	2	15
Florida	188	114	61
Alabama	4 (+2)*	3	50
Mississippi	16	7	44
Louisiana	25 (+2)*	9	33
Texas	78	31	40
Overall Total	406	204	50

An asterisk (*) indicates additional piping plovers sites not surveyed in the 2006 Census.

Sea-level rise poses a significant threat to all piping plover populations during the migration and wintering portion of their life cycle. Ongoing coastal stabilization activities may strongly influence the effects of sea-level rise on piping plover habitat. Improved understanding of how sea-level rise will affect the quality and quantity of habitat for migrating and wintering piping plovers is an urgent need.

Storm events

Although coastal piping plover habitats are storm-created and maintained, the 1996 Atlantic Coast Recovery Plan also noted that storms and severe cold weather may take a toll on piping plovers, and the 2003 Great Lakes Recovery Plan postulated that loss of habitats such as overwash passes or wrack, where birds shelter during harsh weather, poses a threat.

Storms are a component of the natural processes that form coastal habitats used by migrating and wintering piping plovers, and positive effects of storm-induced overwash and vegetation removal have been noted in portions of the wintering range. For example, Gulf Islands National Seashore habitats in Florida benefited from increased washover events that created optimal habitat conditions during the 2004 and 2005 hurricane seasons, with biologists reporting piping plover use of these habitats within six months of the storms (Nicholas 2005 pers. communication). Hurricane Katrina (2005) overwashed the mainland beaches of Mississippi, creating many tidal flats where piping plovers were subsequently observed (Winstead 2008). Hurricane Katrina also created a new inlet and improved habitat conditions on some areas of Dauphin Island, Alabama (LeBlanc 2009 pers. communication). Conversely, localized storms, since Katrina, have induced habitat losses on Dauphin Island (LeBlanc 2009 pers. communication).

Noel and Chandler (2005) suspect that changes in habitat caused by multiple hurricanes along the Georgia coastline altered the spatial distribution of piping plovers and may have contributed to winter mortality of three Great Lakes piping plovers. Following Hurricane Ike in 2008, Arvin (2009) reported decreased numbers of piping plovers at some heavily eroded Texas beaches in the center of the storm impact area and increases in plover numbers at sites about 100 miles to the southwest. However, piping plovers were observed later in the season using tidal lagoons and pools that Ike created behind the eroded beaches (Arvin 2009).

The adverse effects on piping plovers attributed to storms are sometimes due to a combination of storms and other environmental changes or human use patterns. For example, four hurricanes between 2002 and 2005 are often cited in reference to rapid erosion of the Chandeleur Islands, a chain of low-lying islands in Louisiana where the 1991 International Piping Plover Census tallied more than 350 piping plovers. Comparison of imagery taken three years before and several days after Hurricane Katrina found that the Chandeleur Islands lost 82% of their surface area (Sallenger et al. 2009 in review), and a review of aerial photography prior to the 2006 Census suggested little piping plover habitat remained (Elliott-Smith et al. 2009). However, Sallenger et al. (2009 in review) noted that habitat changes in the Chandeleurs stem not only from the effects of these storms but rather from the combined effects of the storms, long-term (>1,000 years) diminishing sand supply, and sea-level rise relative to the land.

Other storm-induced adverse effects include post-storm acceleration of human activities such as beach nourishment, sand scraping, and berm and seawall construction. Such stabilization activities can result in the loss and degradation of feeding and resting habitats. Storms also can cause widespread deposition of debris along beaches. Removal of debris often requires large machinery, which can cause extensive disturbance and adversely affect habitat elements such as wrack. Another example of indirect adverse effects linked to a storm event is the increased access to Pelican Island (LeBlanc 2009 pers. communication) due to merging with Dauphin Island following a 2007 storm (Gibson et al. 2009).

Recent climate change studies indicate a trend toward increasing hurricane numbers and intensity (Emanuel 2005; Webster et al. 2005). When combined with predicted effects of sea-level rise, there may be increased cumulative impacts from future storms.

In sum, storms can create or enhance piping plover habitat while causing localized losses elsewhere in the wintering and migration range. Available information suggests that some birds may have resiliency to storms and move to unaffected areas without harm, while other reports suggest birds may perish from storm events. Significant concerns include disturbance to piping plovers and habitats during cleanup of debris, and post-storm acceleration of shoreline stabilization activities, which can cause persistent habitat degradation and loss.

Summary

Habitat loss and degradation on winter and migration grounds from shoreline and inlet stabilization efforts, both within and outside of designated critical habitat, remain a serious threat to all piping plover populations. Modeling strongly suggests that the population is very sensitive to adult and juvenile survival. Therefore, while there is a great deal of effort extended to improve breeding success, to improve and maintain a higher population over time, it is also necessary to ensure that the wintering habitat, where birds spend most of their time, is secure. On the wintering grounds, the shoreline areas used by wintering piping plovers are being developed, stabilized, or otherwise altered, making it unsuitable. Even in areas where habitat conditions are appropriate, human disturbance on beaches may negatively impact piping plovers' energy budget, as they may spend more time being vigilant and less time in foraging and roosting behavior. In many cases, the disturbance is severe enough, that piping plovers appear to avoid some areas altogether. Threats on the wintering grounds may impact piping plovers' breeding success if they start migration or arrive at the breeding grounds with a poor body condition.

5) Analysis of the Species Likely to be Affected

The proposed action has the potential to adversely affect wintering and migrating piping plovers and their habitat from all breeding populations that may use the Action Area. The Atlantic Coast breeding population of piping plover is listed as threatened, while the Great Lakes breeding population is listed as endangered. Potential effects to piping plover include direct loss of foraging and roosting habitat in the Action Area and in the updrift and downdrift portions the beach, degradation of foraging habitat and destruction of the prey base from sand disposal, and attraction of predators due to food waste from the construction crew. Plovers face predation by avian and mammalian predators that are present year-round on the wintering and nesting grounds. The stabilization of the shoreline may also result in less suitable nesting habitat for the piping plover and other nesting shorebirds.

B. Environmental Baseline

North Carolina barrier beaches are part of a complex and dynamic coastal system that continually responds to inlets, tides, waves, erosion and deposition, longshore sediment transport, and depletion, fluctuations in sea level, and weather events. The location and shape of the coastline perpetually adjusts to these physical forces. Winds move sediment across the dry beach forming dunes and the island interior landscape. The natural communities contain plants and animals that are subject to shoreline erosion and deposition, salt spray, wind, drought conditions, and sandy soils. Vegetative communities include foredunes, primary and secondary dunes, interdunal swales, sand pine scrub, and maritime forests.

During storm events, overwash across the barrier islands is common, depositing sediments on the bayside, clearing vegetation and increasing the amount of open, sandflat habitat ideal for shoreline dependent shorebirds. However, the protection or persistence of these important natural land forms, processes, and wildlife resources is often in conflict with long-term beach stabilization projects and their indirect effects, i.e., increases in residential development, infrastructure, and public recreational uses, and preclusion of overwash which limits the creation of open sand flats preferred by piping plovers.

1) Status of the Species within the Action Area

On Ocean Isle and Holden Beach, the 2006 International Piping Plover Census surveys documented 4 wintering piping plovers on the east end of Ocean Isle, and no breeding piping plovers (Elliott-Smith et al. 2009). Data provided by the NCWRC indicate as many as 39 piping plovers on Ocean Isle and Holden Beach in 2001, with a high of 13 observations in March of that year. See **Table 9**, below.

Table 9. Number of piping plovers observed between 1987 and 2012 on Ocean Isle and Holden Beach. The data includes some years with multiple surveys, so numbers may not represent individual birds.

Year	Number of Piping Plovers
1987	2
1988	0
1989	4
1990	8
1991	6
1992	8
1993	8
1994	2
1995	2
1996	1
1997	7
1998	8
1999	7
2000	8
2001	39
2002	25
2003	0
2004	3
2005	4
2006	7
2007	8
2008	14
2009	2
2011	9
2012	0

From data provided in the BA, as many as 4 breeding pairs of piping plovers have been documented in the Action Area between 1987 and 2012. (**Table 10**).

Table 10. Number of breeding pairs of piping plovers observed between 1987 and 2012 on Ocean Isle and Holden Beach.

Year	Number of Piping Plover breeding pairs
1987	1
1988	0
1989	2
1990	2
1991	2
1992	4
1993	4
1994	1
1995	1
1996	0
1997	2
1998	4
1999	0
2000	0
2001	0
2002	0
2003	0
2004	0
2005	0
2006	0
2007	1
2008	0
2009	0
2011	0
2012	0

2) Factors Affecting the Species Environment within the Action Area

A number of recent and on-going beach disturbance activities have altered the proposed Action Area and, to a greater extent, the North Carolina coastline, and many more are proposed along the coastline for the near future. **Table 3** (page 53) lists the most recent projects within the past 5 years.

Pedestrian Use of the Beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from hotels, beachfront and nearby residences.

Sand nourishment: The beaches of Ocean Isle and Holden Beach are regularly nourished with sand from the Corps' CSDR project. Nourishment activities widen beaches, change their sedimentology and stratigraphy, alter coastal processes and often plug dune gaps and remove overwash areas.

Inlet dredging activities alter the sediment dynamics on adjacent shorelines and stabilize these dynamic environments; beach disposal of dredge material further alters the natural habitat adjacent to inlets. Estuarine dredging of navigational channels can alter water circulation patterns and sediment transport pathways, as well as increase the frequency and magnitude of boat wakes; sound-side sand or mud flats may be impacted by increased erosion rates as a result. The Corps has regularly dredged Shallotte Inlet every few years since 2001 as part of the Ocean Isle Coastal Storm Damage Reduction (CSDR), and the sediment has been disposed on Ocean Isle.

Beach scraping or bulldozing can artificially steepen beaches, stabilize dune scarps, plug dune gaps, and redistribute sediment distribution patterns. Artificial dune building, often a product of beach scraping, removes low-lying overwash areas and dune gaps. As chronic erosion catches up to structures throughout the Action Area, artificial dune systems are constructed and maintained to protect beachfront structures either by sand fencing or fill placement. Beach scraping or bulldozing has been frequent on North Carolina beaches in recent years, in response to storms and the continuing retreat of the shoreline with rising sea level. These activities primarily occur during the winter months. Artificial dune or berm systems have been constructed and maintained in several areas. These dunes make the artificial dune ridge function like a seawall that blocks natural beach retreat, evolution, and overwash.

Sandbags and revetments are vertical structures built parallel to the beach in front of buildings, roads, and other facilities to protect them from erosion. However, these structures often accelerate erosion by causing scouring in front of and downdrift from the structure (Hayes and Michel 2008), which can eliminate piping plover habitat. Geotubes (long cylindrical bags made of high-strength permeable fabric and filled with sand) and sandbag revetments are softer alternatives, but act as barriers by preventing overwash. There are two existing rock revetments along the coast of North Carolina: one at Fort Fisher (approximately 3,040 lf), and another along Carolina Beach (approximately 2,050 lf). Sandbags and sandbag revetments have been placed along at least 1,400 lf of the Action Area on Ocean Isle Beach. A sandbag revetment at least 1,500 lf long was constructed in 2015 at the north end of North Topsail Beach.

C. Effects of the Action

This section is an analysis of the beneficial, direct and indirect effects of the proposed action on migrating, wintering, and breeding piping plovers within the Action Area. The analysis includes effects interrelated and interdependent of the project activities. An interrelated activity is an activity that is part of a proposed action and depends on the proposed activity. An interdependent activity is an activity that has no independent utility apart from the action.

1) Factors to be Considered

The proposed project will occur within habitat used by migrating, wintering, and breeding piping plovers and construction will occur during a portion of the migration and winter seasons. Long-term and permanent impacts could preclude the creation of new habitat and increase recreational disturbance. Short-term and temporary impacts to piping plovers could result from project work disturbing roosting plovers and degrading currently occupied foraging areas.

Proximity of the action: Construction of the groin and sand placement activities would occur within and adjacent to foraging and roosting breeding habitats for migrating or wintering piping plovers, and potential breeding habitat.

Distribution: Project construction activities that may impact migrants and the wintering population of piping plovers, and potential breeding piping plovers would occur along the eastern end of Ocean Isle and western end of Holden Beach.

Timing: The timing of project construction could directly and indirectly impact migrating and wintering piping plovers. Piping plovers and red knots may be present year-round in the Action Area, however, the timing of sand placement and groin construction activities will likely occur during the migration and wintering period (July to May).

Nature of the effect: The effects of the project construction include a temporary reduction in foraging and resting habitat and nesting habitat, a long-term decreased rate of change that may preclude habitat creation, and increased recreational disturbance. A decrease in the survival of piping plovers on the migration and winter grounds due to the lack of optimal habitat may contribute to decreased survival rates, decreased productivity on the breeding grounds, and increased vulnerability to the three populations.

Although the Service expects direct short-term effects from disturbance during project construction, it is anticipated the action will also result in direct and indirect, long term effects to piping plovers. Direct effects to piping plovers and their habitat as a result of groin and jetty repair or replacement will primarily be due to construction ingress and egress when construction is required to be conducted from land. In addition, construction materials and equipment may need to be stockpiled on the beach. Piping plover habitats would remain disturbed until the project is completed and the habitats are restored. The direct effects would be expected to be short-term in duration, until the benthic community reestablishes within the new beach profile. Indirect effects from the activity, including those related to altered sand transport systems, may continue to occur as long as the groin remains on the beach. Due to downdrift erosion, there may be loss or degradation of piping plover Critical Habitat Unit NC-17. The Service expects there may be morphological changes to piping plover habitat and critical habitat, including roosting, foraging, and nesting habitat.

Duration: Groin installation will be a one-time activity, which will take as long as 4 ½ months to complete. Sand fillet maintenance will be a recurring activity and will take up to 10 weeks to complete each time. Thus, the direct effects would be expected to be short-term in duration. After each dredging event, the loss of any Critical Habitat in the intertidal shoals will not be recovered unless and until sand movement again creates shoals in the project area. Indirect effects from the activity may continue to impact migrating, wintering, and breeding plovers in subsequent seasons after sand placement. The habitat will be temporarily unavailable to wintering plovers during the construction period, and the quality of the habitat will be reduced for several months or perhaps years following project activities. The mean linear distance moved by wintering plovers from their core area is estimated to be approximately 2.1 miles (Drake et al. 2001), suggesting they could be negatively impacted by temporary disturbances anywhere in their core habitat area. Erosion and loss of habitat down-drift of the groin may increase after project completion and have long term-impacts.

Disturbance frequency: Disturbance from groin construction activities will be short-term lasting up to two years. Recreational disturbance may increase after project completion and have long term-impacts. Disturbance from maintenance of the sand fillet can be anticipated every 5 years for the life of the project.

Disturbance intensity and severity: Project construction is anticipated to be conducted during portions of the piping plover migration, winter, and nesting seasons. Conservation measures have been incorporated into the project to minimize impacts. The Action Area encompasses an area in the nesting and wintering range of the piping plover; however, the overall intensity of the disturbance is expected to be minimal. The intensity of the effect on piping plover habitat may vary depending on the frequency of the sand placement activities, the existence of staging areas, and the location of the beach access points. The severity of direct impacts is also likely to be slight, as plovers located within the Action Area are expected to move outside of the construction zone due to disturbance; therefore, no plovers are expected to be directly taken as a result of this action.

2) Analyses for Effects of the Action

Beneficial effects: For some highly eroded beaches, sand placement will have a beneficial effect on the habitat's ability to support wintering piping plovers. Narrow beaches that do not support a productive wrack line may see an improvement in foraging habitat available to piping plovers following sand placement. The addition of sand to the sediment budget may also increase a sand-starved beach's likelihood of developing habitat features valued by piping plovers, including washover fans and emergent nearshore sand bars.

Direct effects: Direct effects are those direct or immediate effects of a project on the species or its habitat. The construction window (i.e., beach renourishment and groin installation) will extend through one or more piping plover migration and winter seasons. Since piping plovers can be present on these beaches year-round, construction is likely to occur while this species is utilizing these beaches and associated habitats. Heavy machinery and equipment (e.g., trucks and bulldozers operating on Action Area beaches, the placement of the dredge pipeline along the beach, and sand disposal) may adversely affect piping plovers in the Action Area by disturbance and disruption of normal activities such as roosting and foraging, and possibly forcing birds to expend valuable energy reserves to seek available habitat elsewhere.

Burial and suffocation of invertebrate species will occur during each nourishment and renourishment cycle. Impacts from maintenance of the sand fillet will affect at least 3,214 lf of shoreline. Timeframes projected for benthic recruitment and re-establishment following beach nourishment are between 6 months to 2 years.

Maintenance dredging of shallow-draft inlets can occasionally require the removal of emergent shoals that may have formed at the location of the Federally-authorized channel from the migration of the channel over time. In these cases, the dredging activities would result in a complete take of that habitat. However, this take could be either temporary or more permanent in nature depending upon the location of future shoaling within the inlet.

Indirect effects: The proposed project includes beach renourishment and groin installation along approximately 3,500 lf of shoreline as protective elements against shoreline erosion to protect man-made infrastructure. Indirect effects include reducing the potential for the formation of optimal foraging, roosting, and nesting habitat, erosion and loss of habitat downdrift of the groin, and increasing the attractiveness of these beaches for recreation increasing recreational pressures within the Action Area. Recreational activities that potentially adversely affect plovers include disturbance by unleashed pets and increased pedestrian use.

3) Species' Response to the Proposed Action

The Service anticipates potential adverse effects throughout the Action Area by limiting proximity to roosting, foraging, and nesting habitat, degrading occupied foraging habitat, and increasing disturbance from increased recreational use.

Elliott and Teas (1996) found a significant difference in actions between piping plovers encountering pedestrians and those not encountering pedestrians. Piping plover encountering pedestrians spend proportionately more time in non-foraging behavior. This study suggests that interactions with pedestrians on beaches cause birds to shift their activities from calorie acquisition to calorie expenditure. In winter and migration sites, human disturbance continues to decrease the amount of undisturbed habitat and appears to limit local piping plover abundance (Zonick and Ryan 1996).

Disturbance also reduces the time migrating shorebirds spend foraging (Burger 1991). Pfister et al. (1992) implicate disturbance as a factor in the long-term decline of migrating shorebirds at staging areas. While piping plover migration patterns and needs remain poorly understood and occupancy of a particular habitat may involve shorter periods relative to wintering, information about the energetics of avian migration indicates that this might be a particularly critical time in the species' life cycle.

D. Cumulative Effects

This project occurs on non-federal lands. Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion.

It is reasonable to expect continued shoreline stabilization and beach renourishment projects in this area in the future since erosion and sea-level rise increases would impact the existing beachfront development.

VI. RED KNOT

A. Status of the Species/Critical Habitat

1) Species/Critical Habitat Description

On December 11, 2014, the Service listed the rufa red knot (*Calidris canutus rufa*) (or red knot) as threatened throughout its range.

The red knot is a medium-sized shorebird about 9 to 11 inches (in) (23 to 28 centimeters (cm)) in length. The red knot migrates annually between its breeding grounds in the Canadian Arctic and several wintering regions, including the Southeast United States (Southeast), the Northeast Gulf of Mexico, northern Brazil, and Tierra del Fuego at the southern tip of South America. During both the northbound (spring) and southbound (fall) migrations, red knots use key staging and stopover areas to rest and feed. Red knots migrate through and overwinter in North Carolina. The term "winter" is used to refer to the nonbreeding period of the red knot life cycle when the birds are not undertaking migratory movements. Red knots are most common in North Carolina during the migration season (mid-April through May and July to Mid-October), and may be present in the state throughout the year (Fussell 1994; Potter et al. 1980). Wintering areas for the red knot include the Atlantic coasts of Argentina and Chile, the north coast of Brazil, the Northwest Gulf of Mexico from the Mexican State of Tamaulipas through Texas to Louisiana, and the Southeast United States from Florida to North Carolina (Newstead et al. 2013; Niles et al. 2008). Smaller numbers of knots winter in the Caribbean, and along the central Gulf coast, the mid-Atlantic, and the Northeast United States. Little information exists on where juvenile red knots spend the winter months (USFWS and Conserve Wildlife Foundation 2012), and there may be at least partial segregation of juvenile and adult red knots on the wintering grounds. There is no designation of critical habitat for red knot.

2) Life History

Each year red knots make one of the longest distance migrations known in the animal kingdom, traveling up to 19,000 miles (mi) (30,000 kilometers (km) annually between breeding grounds in the Arctic Circle and wintering grounds. Red knots undertake long flights that may span thousands of miles without stopping. As they prepare to depart on long migratory flights, they undergo several physiological changes. Before takeoff, the birds accumulate and store large amounts of fat to fuel migration and undergo substantial changes in metabolic rates. In addition, leg muscles, gizzard (a muscular organ used for grinding food), stomach, intestines, and liver all decrease in size, while pectoral (chest) muscles and heart increase in size. Due to these physiological changes, red knots arriving from lengthy migrations are not able to feed maximally until their digestive systems regenerate, a process that may take several days. Because stopovers are time-constrained, red knots require stopovers rich in easily-digested food to achieve adequate weight gain (Niles et al. 2008; van Gils et al. 2005a; van Gils et al. 2005b; Piersma et al. 1999) that fuels the next migratory flight and, upon arrival in the Arctic, fuels a body transformation to breeding condition (Morrison 2006). Red knots from different wintering areas appear to employ different migration strategies, including differences in timing, routes, and stopover areas. However, full segregation of migration strategies, routes, or stopover areas does not occur among red knots from different wintering areas.

Major spring stopover areas along the Mid- and South Atlantic coast include Río Gallegos, Península Valdés, and San Antonio Oeste (Patagonia, Argentina); Lagoa do Peixe (eastern Brazil, State of Rio Grande do Sul); Maranhão (northern Brazil); the Virginia barrier islands (United States); and Delaware Bay (Delaware and New Jersey, United States) (Cohen et al. 2009; Niles et al. 2008; González 2005). Important fall stopover sites include southwest Hudson Bay (including the Nelson River delta), James Bay, the north shore of the St. Lawrence River, the Mingan Archipelago, and the Bay of Fundy in Canada; the coasts of Massachusetts and New Jersey and the mouth of the Altamaha River in Georgia, United States; the Caribbean (especially Puerto Rico and the Lesser Antilles); and the northern coast of South America from Brazil to Guyana (Newstead et al. 2013; Niles 2012; Niles et al. 2010; Schneider and Winn 2010; Niles et al. 2008; Antas and Nascimento 1996; Morrison and Harrington 1992; Spaans 1978). However, large and small groups of red knots, sometimes numbering in the thousands, may occur in suitable habitats all along the Atlantic and Gulf coasts from Argentina to Canada during migration (Niles et al. 2008).

Some red knots wintering in the Southeastern United States and the Caribbean migrate north along the U.S. Atlantic coast before flying overland to central Canada from the mid-Atlantic, while others migrate overland directly to the Arctic from the Southeastern U.S. coast (Niles et al. 2012). These eastern red knots typically make a short stop at James Bay in Canada, but may also stop briefly along the Great Lakes, perhaps in response to weather conditions (Niles et al. 2008; Morrison and Harrington 1992). Red knots are restricted to the ocean coasts during winter, and occur primarily along the coasts during migration. However, small numbers of rufa red knots are reported annually across the interior United States (i.e., greater than 25 miles from the Gulf or Atlantic Coasts) during spring and fall migration—these reported sightings are concentrated along the Great Lakes, but multiple reports have been made from nearly every interior State (eBird.org 2012).

Long-distance migrant shorebirds are highly dependent on the continued existence of quality habitat at a few key staging areas. These areas serve as stepping stones between wintering and breeding areas. Conditions or factors influencing shorebird populations on staging areas control much of the remainder of the annual cycle and survival of the birds (Skagen 2006; International Wader Study Group 2003). At some stages of migration, very high proportions of entire populations may use a single migration staging site to prepare for long flights. Red knots show some fidelity to particular migration staging areas between years (Duerr et al. 2011; Harrington 2001).

Habitats used by red knots in migration and wintering areas are similar in character, generally coastal marine and estuarine (partially enclosed tidal area where fresh and salt water mixes) habitats with large areas of exposed intertidal sediments. In North America, red knots are commonly found along sandy, gravel, or cobble beaches, tidal mudflats, salt marshes, shallow coastal impoundments and lagoons, and peat banks (Cohen et al. 2010; Cohen et al. 2009; Niles et al. 2008; Harrington 2001; Truitt et al. 2001). The supra-tidal (above the high tide) sandy habitats of inlets provide important areas for roosting, especially at higher tides when intertidal habitats are inundated (Harrington 2008).

The red knot is a specialized molluscivore, eating hard-shelled mollusks, sometimes supplemented with easily accessed softer invertebrate prey, such as shrimp- and crab-like organisms, marine worms, and horseshoe crab (*Limulus polyphemus*) eggs (Piersma and van Gils 2011; Harrington 2001). Mollusk prey are swallowed whole and crushed in the gizzard (Piersma and van Gils 2011). Foraging activity is largely dictated by tidal conditions, as red knots rarely wade in water more than 0.8 to 1.2 in (2 to 3 cm) deep (Harrington 2001). Due to bill morphology, the red knot is limited to foraging on only shallow-buried prey, within the top 0.8 to 1.2 in (2 to 3 cm) of sediment (Gerasimov 2009; Zwarts and Blomert 1992).

The primary prey of the rufa red knot in non-breeding habitats include blue mussel (*Mytilus edulis*) spat (juveniles); *Donax* and *Darina* clams; snails (*Littorina spp.*), and other mollusks, with polycheate worms, insect larvae, and crustaceans also eaten in some locations. A prominent departure from typical prey items occurs each spring when red knots feed on the eggs of horseshoe crabs, particularly during the key migration stopover within the Delaware Bay of New Jersey and Delaware. Delaware Bay serves as the principal spring migration staging area for the red knot because of the availability of horseshoe crab eggs (Clark et al. 2009; Harrington 2001; Harrington 1996; Morrison and Harrington 1992), which provide a superabundant source of easily digestible food.

Red knots and other shorebirds that are long-distance migrants must take advantage of seasonally abundant food resources at intermediate stopovers to build up fat reserves for the next non-stop, long-distance flight (Clark et al. 1993). Although foraging red knots can be found widely distributed in small numbers within suitable habitats during the migration period, birds tend to concentrate in those areas where abundant food resources are consistently available from year to year.

3) Population Dynamics

In the United States, red knot populations declined sharply in the late 1800s and early 1900s due to excessive sport and market hunting, followed by hunting restrictions and signs of population recovery by the mid-1900s (Urner and Storer 1949; Stone 1937; Bent 1927). However, it is unclear whether the red knot population fully recovered its historical numbers (Harrington 2001) following the period of unregulated hunting. More recently, long-term survey data from two key areas (Tierra del Fuego wintering area and Delaware Bay spring stopover site) both show a roughly 75 percent decline in red knot numbers since the 1980s (Dey et al. 2011; Clark et al. 2009; Morrison et al. 2004; Morrison and Ross 1989; Kochenberger 1983; Dunne et al. 1982; Wander and Dunne, 1982).

For many portions of the knot's range, available survey data are patchy. Prior to the 1980s, numerous natural history accounts are available, but provide mainly qualitative or localized population estimates. No population information exists for the breeding range because, in breeding habitats, red knots are thinly distributed across a huge and remote area of the Arctic. Despite some localized survey efforts, (e.g., Niles et al. 2008), there are no regional or comprehensive estimates of breeding abundance, density, or productivity (Niles et al. 2008).

Counts in wintering areas are useful in estimating red knot populations and trends because the birds generally remain within a given wintering area for a longer period of time compared to the areas used during migration. This eliminates errors associated with turnover or double-counting that can occur during migration counts. Harrington et al. (1988) reported that the mean count of birds wintering in Florida was 6,300 birds (± 3,400, one standard deviation) based on 4 aerial surveys conducted from October to January in 1980 to 1982. Based on these surveys and other work, the Southeast wintering group was estimated at roughly 10,000 birds in the 1970s and 1980s (Harrington 2005a).

Based on resightings of birds banded in South Carolina and Georgia from 1999 to 2002, the Southeast wintering population was estimated at 11,700 ± 1,000 (standard error) red knots. Although there appears to have been a gradual shift by some of the southeastern knots from the Florida Gulf coast to the Atlantic coasts of Georgia and South Carolina, population estimates for the Southeast region in the 2000s were at about the same level as during the 1980s (Harrington 2005a). Based on recent modeling using resightings of marked birds staging in Georgia in fall, as well as other evidence, the Southeast wintering group may number as high as 20,000 (B.

Harrington pers. comm. November 12, 2012), but field survey data are not available to corroborate this estimate.

Beginning in 2006, coordinated red knot surveys have been conducted from Florida to Delaware Bay during 2 consecutive days from May 20 to 24 (**Table 11**). This period is thought to represent the peak of the red knot migration. There has been variability in methods, observers, and areas covered. From 2006 to 2010, there was no change in counts that could not be attributed to varying geographic survey coverage (Dey et al. 2011); thus, we do not consider any apparent trends in these data before 2010.

Table 11. Red knot counts along the Atlantic coast of the United States, May 20 to 24, 2006 to 2012 (A. Dey pers. comm. October 12, 2012; Dey et al. 2011).

<table>
<tr><th>State</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th><th>2012</th></tr>
<tr><td>New Jersey</td><td>7,860</td><td>4,445</td><td>10,045</td><td rowspan="2">16,229</td><td>8,945</td><td>7,737</td><td>23,525</td></tr>
<tr><td>Delaware</td><td>820</td><td>2,950</td><td>5,350</td><td>5,530</td><td>5,067</td><td>3,433</td></tr>
<tr><td>Maryland</td><td></td><td></td><td>663</td><td>78</td><td>5</td><td>83</td><td>139</td></tr>
<tr><td>Virginia</td><td>5,783</td><td>5,939</td><td>7,802</td><td>3,261</td><td>8,214</td><td>6,236</td><td>8,482</td></tr>
<tr><td>North Carolina</td><td>235</td><td>304</td><td>1,137</td><td>1,466</td><td>1,113</td><td>1,868</td><td>2,832</td></tr>
<tr><td>South Carolina</td><td></td><td>125</td><td>180</td><td>10</td><td>1,220</td><td>315</td><td>542</td></tr>
<tr><td>Georgia</td><td>796</td><td>2,155</td><td>1,487</td><td></td><td>260</td><td>3,071</td><td>1,466</td></tr>
<tr><td>Florida</td><td></td><td></td><td>868</td><td>800</td><td>41</td><td></td><td>10</td></tr>
<tr><td>Total</td><td>15,494</td><td>15,918</td><td>27,532</td><td>21,844</td><td>25,328</td><td>24,377</td><td>40,429</td></tr>
</table>

Because red knot numbers peak earlier in the Southeast than in the mid-Atlantic (M. Bimbi pers. comm. June 27, 2013), the late-May coast-wide survey data likely reflect the movement of some birds north along the coast, and may miss other birds that depart for Canada from the Southeast along an interior (overland) route prior to the survey window. Thus, greater numbers of red knots may utilize Southeastern stopovers than suggested by the data in **Table 11**. For example, a peak count of over 8,000 red knots was documented in South Carolina during spring 2012 (South Carolina Department of Natural Resources 2012). Dinsmore et al. (1998) found a mean of 1,363 (±725) red knots in North Carolina during spring 1992 and 1993, with a peak count of 2,764 birds.

4) Status and Distribution

Reason for listing: The Service has determined that the rufa red knot is threatened due to loss of both breeding and nonbreeding habitat; potential for disruption of natural predator cycles on the breeding grounds; reduced prey availability throughout the nonbreeding range; and increasing frequency and severity of asynchronies ("mismatches") in the timing of the birds' annual migratory cycle relative to favorable food and weather conditions.

Range-Wide Trends:

Wintering areas for the red knot include the Atlantic coasts of Argentina and Chile, the north coast of Brazil, the Northwest Gulf of Mexico from the Mexican State of Tamaulipas through Texas to Louisiana, and the Southeast United States from Florida to North Carolina (Newstead et al. 2013; L. Patrick pers. comm. August 31, 2012; Niles et al. 2008). Smaller numbers of knots winter in the Caribbean, and along the central Gulf coast (Alabama, Mississippi), the mid-Atlantic, and the Northeast United States. *Calidris canutus* is also known to winter in Central America and northwest South America, but it is not yet clear if all these birds are the *rufa* subspecies.

In some years, more red knots have been counted during a coordinated spring migration survey than can be accounted for at known wintering sites, suggesting there are unknown wintering areas. Indeed, geolocators have started revealing previously little-known wintering areas, particularly in the Caribbean (Niles et al. 2012; L. Niles pers. comm. January 8, 2013).

The core of the Southeast wintering area (i.e., that portion of this large region supporting the majority of birds) is thought to shift from year to year among Florida, Georgia, and South Carolina (Niles et al. 2008). However, the geographic limits of this wintering region are poorly defined. Although only small numbers are known, wintering knots extend along the Atlantic coast as far north as Virginia (L. Patrick pers. comm. August 31, 2012; Niles et al. 2006), Maryland (Burger et al. 2012), and New Jersey (BandedBirds.org 2012; H. Hanlon pers. comm. November 22, 2012; A. Dey pers. comm. November 19, 2012). Still smaller numbers of red knots have been reported between December and February from Long Island, New York, through Massachusetts and as far north as Nova Scotia, Canada (eBird.org 2012).

Recovery Criteria

A Recovery Plan for the red knot has not yet been completed. It will be developed, pursuant to Subsection 4(f) of the ESA, in the near future.

Threats to the Red Knot

Within the nonbreeding portion of the range, red knot habitat is primarily threatened by the highly interrelated effects of sea level rise, shoreline stabilization, and coastal development. Lesser threats to nonbreeding habitat include agriculture and aquaculture, invasive vegetation, and beach maintenance activities. Within the breeding portion of the range, the primary threat to red knot habitat is from climate change. With arctic warming, vegetation conditions in the breeding grounds are expected to change, causing the zone of nesting habitat to shift and perhaps contract. Arctic freshwater systems—foraging areas for red knots during the nesting season—are particularly sensitive to climate change. For more information, please see the proposed and final rules and supplemental documents on the Internet at *http://www.regulations.gov* (Docket Number FWS–R5–ES–2013–0097).

Climate Change & Sea Level Rise

The natural history of Arctic-breeding shorebirds makes this group of species particularly vulnerable to global climate change (Meltofte et al. 2007; Piersma and Lindström 2004; Rehfisch and Crick 2003; Piersma and Baker 2000; Zöckler and Lysenko 2000; Lindström and Agrell 1999). Relatively low genetic diversity, which is thought to be a consequence of survival through past climate-driven population bottlenecks, may put shorebirds at more risk from human-induced climate variation than other avian taxa (Meltofte et al. 2007); low genetic diversity may result in reduced adaptive capacity as well as increased risks when population sizes drop to low levels.

In the short term, red knots may benefit if warmer temperatures result in fewer years of delayed horseshoe crab spawning in Delaware Bay (Smith and Michaels 2006) or fewer occurrences of late snow melt in the breeding grounds (Meltofte et al. 2007). However, there are indications that changes in the abundance and quality of red knot prey are already underway (Escudero et al. 2012; Jones et al. 2010), and prey species face ongoing climate-related threats from warmer temperatures (Jones et al. 2010; Philippart et al. 2003; Rehfisch and Crick 2003), ocean acidification (NRC 2010; Fabry et al. 2008), and possibly increased prevalence of disease and parasites (Ward and Lafferty 2004). In addition, red knots face imminent threats from loss of habitat caused by sea level rise (NRC 2010; Galbraith et al. 2002; Titus 1990), and increasing asynchronies ("mismatches") between the timing of their annual breeding, migration, and wintering cycles and the windows of peak food availability on which the birds depend (Smith et al. 2011; McGowan et al. 2011; Meltofte et al. 2007; van Gils et al. 2005a; Baker et al. 2004).

With arctic warming, vegetation conditions in the red knot's breeding grounds are expected to change, causing the zone of nesting habitat to shift and perhaps contract, but this process may take decades to unfold (Feng et al. 2012; Meltofte et al. 2007; Kaplan et al. 2003). Ecological shifts in the Arctic may appear sooner. High uncertainty exists about when and how changing interactions among vegetation, predators, competitors, prey, parasites, and pathogens may affect the red knot, but the impacts are potentially profound (Fraser et al. 2013; Schmidt et al. 2012; Meltofte et al. 2007; Ims and Fuglei 2005).

For most of the year, red knots live in or immediately adjacent to intertidal areas. These habitats are naturally dynamic, as shorelines are continually reshaped by tides, currents, wind, and storms. Coastal habitats are susceptible to both abrupt (storm-related) and long-term (sea level rise) changes. Outside of the breeding grounds, red knots rely entirely on these coastal areas to fulfill their roosting and foraging needs, making the birds vulnerable to the effects of habitat loss from rising sea levels. Because conditions in coastal habitats are also critical for building up nutrient and energy stores for the long migration to the breeding grounds, sea level rise affecting conditions on staging areas also has the potential to impact the red knot's ability to breed successfully in the Arctic (Meltofte et al. 2007).

According to the NRC (2010), the rate of global sea level rise has increased from about 0.02 in (0.6 mm) per year in the late 19th century to approximately 0.07 in (1.8 mm) per year in the last half of the 20th century. The rate of increase has accelerated, and over the past 15 years has been in excess of 0.12 in (3 mm) per year. In 2007, the IPCC estimated that sea level would "likely" rise by an additional 0.6 to 1.9 feet (ft) (0.18 to 0.59 meters (m)) by 2100 (NRC 2010). This projection was based largely on the observed rates of change in ice sheets and projected future thermal expansion of the oceans but did not include the possibility of changes in ice sheet dynamics (e.g., rates and patterns of ice sheet growth versus loss). Scientists are working to improve how ice dynamics can be resolved in climate models. Recent research suggests that sea levels could potentially rise another 2.5 to 6.5 ft (0.8 to 2 m) by 2100, which is several times larger than the 2007 IPCC estimates (NRC 2010; Pfeffer et al. 2008). However, projected rates of sea level rise estimates remain rather uncertain, due mainly to limits in scientific understanding of glacier and ice sheet dynamics (NRC 2010; Pfeffer et al. 2008). The amount of sea level change varies regionally because of different rates of settling (subsidence) or uplift of the land, and because of differences in ocean circulation (NRC 2010). In the last century, for example, sea level rise along the U.S. mid- Atlantic and Gulf coasts exceeded the global average by 5 to 6 in (13 to 15 cm) because coastal lands in these areas are subsiding (USEPA 2013). Land subsidence also occurs in some areas of the Northeast, at current rates of 0.02 to 0.04 in (0.5 to 1 mm) per year across this region (Ashton et al. 2007), primarily the result of slow, natural geologic processes (NOAA 2013). Due to regional differences, a 2-ft (0.6-m) rise in global sea level by the end of this century would result in a relative sea level rise of 2.3 ft (0.7 m) at New York City, 2.9 ft (0.9 m) at Hampton Roads, Virginia, and 3.5 ft (1.1 m) at Galveston, Texas (U.S. Global Change Research Program (USGCRP) 2009). **Table 12** shows that local rates of sea level rise in the range of the red knot over the second half of the 20th century were generally higher than the global rate of 0.07 in (1.8 mm) per year.

Table 12. Local sea level trends from within the range of the red knot (NOAA 2012)

Station	Mean Local Sea Level Trend (mm per year)	Data Period
Pointe-Au-Père, Canada	-0.36 ± 0.40	1900–1983
Woods Hole, Massachusetts	2.61 ± 0.20	1932–2006
Cape May, New Jersey	4.06 ± 0.74	1965–2006
Lewes, Delaware	3.20 ± 0.28	1919–2006
Chesapeake Bay Bridge Tunnel, Virginia	6.05 ± 1.14	1975–2006
Beaufort, North Carolina	2.57 ± 0.44	1953–2006
Clearwater Beach, Florida	2.43 ± 0.80	1973–2006
Padre Island, Texas	3.48 ± 0.75	1958–2006
Punto Deseado, Argentina	-0.06 ± 1.93	1970–2002

Data from along the U.S. Atlantic coast suggest a relationship between rates of sea level rise and long-term erosion rates; thus, long-term coastal erosion rates may increase as sea level rises (Florida Oceans and Coastal Council 2010). However, even if such a correlation is borne out, predicting the effect of sea level rise on beaches is more complex. Even if wetland or upland coastal lands are lost, sandy or muddy intertidal habitats can often migrate or reform. However, forecasting how such changes may unfold is complex and uncertain. Potential effects of sea level rise on beaches vary regionally due to subsidence or uplift of the land, as well as the geological character of the coast and nearshore (U.S. Climate Change Science Program (CCSP) 2009b; Galbraith et al. 2002). Precisely forecasting the effects of sea level rise on particular coastal habitats will require integration of diverse information on local rates of sea level rise, tidal ranges, subsurface and coastal topography, sediment accretion rates, coastal processes, and other factors that is beyond the capability of current models (CCSP 2009b; Frumhoff et al. 2007; Thieler and Hammar-Klose 2000; Thieler and Hammar-Klose 1999).

Because the majority of the Atlantic and Gulf coasts consist of sandy shores, inundation alone is unlikely to reflect the potential consequences of sea level rise. Instead, long-term shoreline changes will involve contributions from inundation and erosion, as well as changes to other coastal environments such as wetland losses. Most portions of the open coast of the United States will be subject to significant physical changes and erosion over the next century because the majority of coastlines consist of sandy beaches, which are highly mobile and in a state of continual change (CCSP 2009b).

By altering coastal geomorphology, sea level rise will cause significant and often dramatic changes to coastal landforms including barrier islands, beaches, and intertidal flats (CCSP 2009b; Rehfisch and Crick 2003), primary red knot habitats. Due to increasing sea levels, storm-surge-driven floods now qualifying as 100-year events are projected to occur as often as every 10 to 20 years along most of the U.S. Atlantic coast by 2050, with even higher frequencies of such large floods in certain localized areas (Tebaldi et al. 2012). Rising sea level not only increases the likelihood of coastal flooding, but also changes the template for waves and tides to sculpt the coast, which can lead to loss of land orders of magnitude greater than that from direct inundation alone (Ashton et al. 2007).

Red knot migration and wintering habitats in the U.S. generally consist of sandy beaches that are dynamic and subject to seasonal erosion and accretion. Sea level rise and shoreline erosion have reduced availability of intertidal habitat used for red knot foraging, and in some areas, roosting sites have also been affected (Niles et al. 2008). With moderately rising sea levels, red knot habitats in many portions of the United States would be expected to migrate or reform rather than be lost, except where they are constrained by coastal development or shoreline stabilization (Titus et al. 2009). However, if the sea rises more rapidly than the rate with which a particular coastal system can keep pace, it could fundamentally change the state of the coast (CCSP 2009b).

Climate change is also resulting in asynchronies during the annual cycle of the red knot. The successful annual migration and breeding of red knots is highly dependent on the timing of departures and arrivals to coincide with favorable food and weather conditions. The frequency and severity of asynchronies is likely to increase with climate change. In addition, stochastic encounters with unfavorable conditions are more likely to result in population-level effects for red knots now than when population sizes were larger, as reduced numbers may have reduced the resiliency of this subspecies to rebound from impacts.

For unknown reasons, more red knots arrived late in Delaware Bay in the early 2000s, which is generally accepted as a key causative factor (along with reduced supplies of horseshoe crab eggs) behind red knot population declines that were observed over this same timeframe. Thus, the red knot's sensitivity to timing asynchronies has been demonstrated through a population-level response. Both adequate supplies of horseshoe crab eggs and high-quality foraging habitat in Delaware Bay can serve to partially mitigate minor asynchronies at this key stopover site. However, the factors that caused delays in the spring migrations of red knots from Argentina and Chile are still unknown, and we have no information to indicate if this delay will reverse, persist, or intensify. Superimposed on this existing threat of late arrivals in Delaware Bay are new threats of asynchronies emerging due to climate change. Climate change is likely to affect the reproductive timing of horseshoe crabs in Delaware Bay, mollusk prey species at other stopover sites, or both, possibly pushing the peak seasonal availability of food outside of the windows when red knots rely on them. In addition, both field studies and modeling have shown strong links between the red knot's reproductive output and conditions in the Arctic including insect abundance and snow cover. Climate change may also cause shifts in the period of optimal arctic conditions relative to the time period when red knots currently breed.

Shoreline stabilization

Structural development along the shoreline and manipulation of natural inlets upset the naturally dynamic coastal processes and result in loss or degradation of beach habitat (Melvin et al. 1991). As beaches narrow, the reduced habitat can directly lower the diversity and abundance of biota (life forms), especially in the upper intertidal zone. Shorebirds may be impacted both by reduced habitat area for roosting and foraging, and by declining intertidal prey resources, as has been documented in California (Defeo et al. 2009; Dugan and Hubbard 2006). In Delaware Bay, hard structures also cause or accelerate loss of horseshoe crab spawning habitat (CCSP 2009b; Botton et al. in Shuster et al. 2003; Botton et al. 1988), and shorebird habitat has been, and may continue to be, lost where bulkheads have been built (Clark in Farrell and Martin 1997). In addition to directly eliminating red knot habitat, hard structures interfere with the creation of new shorebird habitats by interrupting the natural processes of overwash and inlet formation. Where hard stabilization is installed, the eventual loss of the beach and its associated habitats is virtually assured (Rice 2009), absent beach nourishment, which may also impact red knots. Where they are maintained, hard structures are likely to significantly increase the amount of red knot habitat lost as sea levels continue to rise.

In a few isolated locations, however, hard structures may enhance red knot habitat, or may provide artificial habitat. In Delaware Bay, for example, Botton et al. (1994) found that, in the same manner as natural shoreline discontinuities like creek mouths, jetties and other artificial obstructions can act to concentrate drifting horseshoe crab eggs and thereby attract shorebirds. Another example comes from the Delaware side of the bay, where a seawall and jetty at Mispillion Harbor protect the confluence of the Mispillion River and Cedar Creek. These structures create a low energy environment in the harbor, which seems to provide highly suitable conditions for horseshoe crab spawning over a wider variation of weather and sea conditions than anywhere else in the bay (G. Breese pers. comm. March 25, 2013). Horseshoe crab egg densities at Mispillion Harbor are consistently an order of magnitude higher than at other bay beaches (Dey et al. 2011), and this site consistently supports upwards of 15 to 20 percent of all the knots recorded in Delaware Bay (Lathrop 2005). Notwithstanding localized red knot use of artificial structures, and the isolated case of hard structures improving foraging habitat at Mispillion Harbor, the nearly universal effect of such structures is the degradation or loss of red knot habitat.

Sand Placement

Where shorebird habitat has been severely reduced or eliminated by hard stabilization structures, beach nourishment may be the only means available to replace any habitat for as long as the hard structures are maintained (Nordstrom and Mauriello 2001), although such habitat will persist only with regular nourishment episodes (typically on the order of every 2 to 6 years). In Delaware Bay, beach nourishment has been recommended to prevent loss of spawning habitat for horseshoe crabs (Kalasz 2008; Carter et al. in Guilfoyle et al. 2007; Atlantic States Marine Fisheries Commission (ASMFC) 1998), and is being pursued as a means of restoring shorebird habitat in Delaware Bay following Hurricane Sandy (Niles et al. 2013; USACE 2012). Beach nourishment was part of a 2009 project to maintain important shorebird foraging habitat at Mispillion Harbor, Delaware (Kalasz pers. comm. March 29, 2013; Siok and Wilson 2011). However, red knots may be directly disturbed if beach nourishment takes place while the birds are present. On New Jersey's Atlantic coast, beach nourishment has typically been scheduled for the fall, when red knots are present, because of various constraints at other times of year. In addition to causing disturbance during construction, beach nourishment often increases recreational use of the widened beaches that, without careful management, can increase disturbance of red knots. Beach nourishment can also temporarily depress, and sometimes permanently alter, the invertebrate prey base on which shorebirds depend. In addition to disturbing the birds and impacting the prey base, beach nourishment can affect the quality and quantity of red knot habitat (M. Bimbi pers. comm. November 1, 2012; Greene 2002). The artificial beach created by nourishment may provide only suboptimal habitat for red knots, as a steeper beach profile is created when sand is stacked on the beach during the nourishment process. In some cases, nourishment is accompanied by the planting of dense beach grasses, which can directly degrade habitat, as red knots require sparse vegetation to avoid predation. By precluding overwash and Aeolian transport, especially where large artificial dunes are constructed, beach nourishment can also lead to further erosion on the bayside and promote bayside vegetation growth, both of which can degrade the red knot's preferred foraging and roosting habitats (sparsely vegetated flats in or adjacent to intertidal areas). Preclusion of overwash also impedes the formation of new red knot habitats. Beach nourishment can also encourage further development, bringing further habitat impacts, reducing future alternative management options such as a retreat from the coast, and perpetuating the developed and stabilized conditions that may ultimately lead to inundation where beaches are prevented from migrating (M. Bimbi pers. comm. November 1, 2012; Greene 2002).

The quantity and quality of red knot prey may also be affected by the placement of sediment for beach nourishment or disposal of dredged material. Invertebrates may be crushed or buried during project construction. Although some benthic species can burrow through a thin layer of additional sediment, thicker layers (over 35 in (90 cm)) smother the benthic fauna (Greene

2002). By means of this vertical burrowing, recolonization from adjacent areas, or both, the benthic faunal communities typically recover. Recovery can take as little as 2 weeks or as long as 2 years, but usually averages 2 to 7 months (Greene 2002; Peterson and Manning 2001). Although many studies have concluded that invertebrate communities recovered following sand placement, study methods have often been insufficient to detect even large changes (e.g., in abundance or species composition), due to high natural variability and small sample sizes (Peterson and Bishop 2005). Therefore, uncertainty remains about the effects of sand placement on invertebrate communities, and how these impacts may affect red knots.

Dredging/sand mining

Many inlets in the U.S. range of the red knot are routinely dredged and sometimes relocated. In addition, nearshore areas are routinely dredged ("mined") to obtain sand for beach nourishment. Regardless of the purpose, inlet and nearshore dredging can affect red knot habitats. Dredging often involves removal of sediment from sand bars, shoals, and inlets in the nearshore zone, directly impacting optimal red knot roosting and foraging habitats (Harrington in Guilfoyle et al. 2007; Winn and Harrington in Guilfoyle et al. 2006). These ephemeral habitats are even more valuable to red knots because they tend to receive less recreational use than the main beach strand. In addition to causing this direct habitat loss, the dredging of sand bars and shoals can preclude the creation and maintenance of red knot habitats by removing sand sources that would otherwise act as natural breakwaters and weld onto the shore over time (Hayes and Michel 2008; Morton 2003). Further, removing these sand features can cause or worsen localized erosion by altering depth contours and changing wave refraction (Hayes and Michel 2008), potentially degrading other nearby red knot habitats indirectly because inlet dynamics exert a strong influence on the adjacent shorelines. Studying barrier islands in Virginia and North Carolina, Fenster and Dolan (1996) found that inlet influences extend 3.4 to 8.1 mi (5.4 to 13.0 km), and that inlets dominate shoreline changes for up to 2.7 mi (4.3 km). Changing the location of dominant channels at inlets can create profound alterations to the adjacent shoreline (Nordstrom 2000).

Reduced food availability

Commercial harvest of horseshoe crabs has been implicated as a causal factor in the decline of the rufa red knot, by decreasing the availability of horseshoe crab eggs in the Delaware Bay stopover (Niles et al. 2008). Notwithstanding the importance of the horseshoe crab and Delaware Bay, other lines of evidence suggest that the rufa red knot also faces threats to its food resources throughout its range.

During most of the year, bivalves and other mollusks are the primary prey for the red knot. Mollusks in general are at risk from climate change-induced ocean acidification (Fabry et al. 2008). Oceans become more acidic as carbon dioxide emitted into the atmosphere dissolves in the ocean. The pH (percent hydrogen, a measure of acidity or alkalinity) level of the oceans has decreased by approximately 0.1 pH units since preindustrial times, which is equivalent to a 25 percent increase in acidity. By 2100, the pH level of the oceans is projected to decrease by an additional 0.3 to 0.4 units under the highest emissions scenarios (NRC 2010). As ocean acidification increases, the availability of calcium carbonate declines. Calcium carbonate is a key building block for the shells of many marine organisms, including bivalves and other mollusks (USEPA 2012; NRC 2010). Vulnerability to ocean acidification has been shown in bivalve species similar to those favored by red knots, including mussels (Gaylord et al. 2011; Bibby et al. 2008) and clams (Green et al. 2009). Reduced calcification rates and calcium metabolism are also expected to affect several mollusks and crustaceans that inhabit sandy beaches (Defeo et al. 2009), the primary nonbreeding habitat for red knots. Relevant to Tierra del Fuego-wintering knots, bivalves have also shown vulnerability to ocean acidification in Antarctic waters, which are predicted to be affected due to naturally low carbonate saturation levels in cold waters (Cummings et al. 2011).

Blue mussel spat is an important prey item for red knots in Virginia (Karpanty et al. 2012). The southern limit of adult blue mussels has contracted from North Carolina to Delaware since 1960 due to increasing air and water temperatures (Jones et al. 2010). Larvae have continued to recruit to southern locales (including Virginia) via currents, but those recruits die early in the summer due to water and air temperatures in excess of lethal physiological limits. Failure to recolonize southern regions will occur when reproducing populations at higher latitudes are beyond dispersal distance (Jones et al. 2010). Thus, this key prey resource may soon disappear from the red knot's Virginia spring stopover habitats (Karpanty et al. 2012).

Reduced food availability at the Delaware Bay stopover site due to commercial harvest and subsequent population decline of the horseshoe crab is considered a primary causal factor in the decline of the rufa subspecies in the 2000s (Escudero et al. 2012; McGowan et al. 2011; CAFF 2010; Niles et al. 2008; COSEWIC 2007; González et al. 2006; Baker et al. 2004; Morrison et al. 2004), although other possible causes or contributing factors have been postulated (Fraser et al. 2013; Schwarzer et al. 2012; Escudero et al. 2012; Espoz et al. 2008; Niles et al. 2008). Due to harvest restrictions and other conservation actions, horseshoe crab populations showed some signs of recovery in the early 2000s, with apparent signs of red knot stabilization (survey counts, rates of weight gain) occurring a few years later. Since about 2005, however, horseshoe crab population growth has stagnated for unknown reasons. Under the current management framework (known as Adaptive Resource Management, or ARM), the present horseshoe crab harvest is not considered a threat to the red knot because harvest levels are tied to red knot populations via scientific modeling. Most data suggest that the volume of horseshoe crab eggs is currently sufficient to support the Delaware Bay's stopover population of red knots at its present size. However, because of the uncertain trajectory of horseshoe crab population growth, it is not yet known if the egg resource will continue to adequately support red knot populations over the next 5 to 10 years. In addition, implementation of the ARM could be impeded by insufficient funding for the shorebird and horseshoe crab monitoring programs that are necessary for the functioning of the ARM models. Many studies have established that red knots stopping over in Delaware Bay during spring migration achieve remarkable and important weight gains to complete their migrations to the breeding grounds by feeding almost exclusively on a superabundance of horseshoe crab eggs. A temporal correlation occurred between increased horseshoe crab harvests in the 1990s and declining red knot counts in both Delaware Bay and Tierra del Fuego by the 2000s. Other shorebird species that rely on Delaware Bay also declined over this period (Mizrahi and Peters in Tanacredi et al. 2009), although some shorebird declines began before the peak expansion of the horseshoe crab fishery (Botton et al. in Shuster et al. 2003).

Hunting

Legal and illegal sport and market hunting in the mid-Atlantic and Northeast United States substantially reduced red knot populations in the 1800s, and we do not know if the subspecies ever fully recovered its former abundance or distribution. Neither legal nor illegal hunting are currently a threat to red knots in the United States, but both occur in the Caribbean and parts of South America. Hunting pressure on red knots and other shorebirds in the northern Caribbean and on Trinidad is unknown. Hunting pressure on shorebirds in the Lesser Antilles (e.g., Barbados, Guadeloupe) is very high, but only small numbers of red knots have been documented on these islands, so past mortality may not have exceeded tens of birds per year. Red knots are no longer being targeted in Barbados or Guadeloupe, and other measures to regulate shorebird hunting on these islands are being negotiated. Much larger numbers (thousands) of red knots occur in the Guianas, where legal and illegal subsistence shorebird hunting is common. About 20 red knot mortalities have been documented in the Guianas, but total red knot hunting mortality in this region cannot be surmised. Subsistence shorebird hunting was also common in northern Brazil, but has decreased in recent decades. We have no evidence that hunting was a driving factor in red knot population declines in the 2000s, or that hunting pressure is increasing. In addition, catch limits, handling protocols, and studies on the effects of research activities on survival all indicate that overutilization for scientific purposes is not a threat to the red knot.

Threats to the red knot from overutilization for commercial, recreational, scientific, or educational purposes exist in parts of the Caribbean and South America. Specifically, legal and illegal hunting does occur. We expect mortality of individual knots from hunting to continue into the future, but at stable or decreasing levels due to the recent international attention to shorebird hunting.

Predation

In wintering and migration areas, the most common predators of red knots are peregrine falcons (*Falco peregrinus*), harriers (*Circus spp.*), accipiters (Family Accipitridae), merlins (*F. columbarius*), shorteared owls (*Asio flammeus*), and greater black-backed gulls (*Larus marinus*) (Niles et al. 2008). Other large are anecdotally known to prey on shorebirds (Breese 2010). In migration areas like Delaware Bay, terrestrial predators such as red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) may be a threat to red knots by causing disturbance, but direct mortality from these predators may be low (Niles et al. 2008).

Although little information is available from the breeding grounds, the long-tailed jaeger (*Stercorarius longicaudus*) is prominently mentioned as a predator of red knot chicks in most accounts. Other avian predators include parasitic jaeger (*S. parasiticus*), pomarine jaeger (*S. pomarinus*), herring gull and glaucous gulls, gyrfalcon (*Falcon rusticolus*), peregrine falcon, and snowy owl (*Bubo scandiacus*). Mammalian predators include arctic fox (*Alopex lagopus*) and sometimes arctic wolves (*Canis lupus arctos*) (Niles et al. 2008; COSEWIC 2007). Predation pressure on Arctic-nesting shorebird clutches varies widely regionally, interannually, and even within each nesting season, with nest losses to predators ranging from close to 0 percent to near 100 percent (Meltofte et al. 2007), depending on ecological factors. Abundance of arctic rodents, such as lemmings, is often cyclical, although less so in North America than in Eurasia. In the Arctic, 3- to 4-year lemming cycles give rise to similar cycles in the predation of shorebird nests. When lemmings are abundant, predators concentrate on the lemmings, and shorebirds breed successfully. When lemmings are in short supply, predators switch to shorebird eggs and chicks (Niles et al. 2008; COSEWIC 2007; Meltofte et al. 2007; USFWS 2003b; Blomqvist et al. 2002; Summers and Underhill 1987).

Recreational disturbance

In some wintering and stopover areas, red knots and recreational users (e.g., pedestrians, ORVs, dog walkers, boaters) are concentrated on the same beaches (Niles et al. 2008; Tarr 2008). Recreational activities affect red knots both directly and indirectly. These activities can cause habitat damage (Schlacher and Thompson 2008; Anders and Leatherman 1987), cause shorebirds to abandon otherwise preferred habitats, and negatively affect the birds' energy balances. Effects to red knots from vehicle and pedestrian disturbance can also occur during construction of shoreline stabilization projects including beach nourishment. Red knots can also be disturbed by motorized and nonmotorized boats, fishing, kite surfing, aircraft, and research activities (Niles et al. 2008; Peters and Otis, 2007; Harrington 2005b; Meyer et al. 1999; Burger 1986) and by beach raking or cleaning.

5) Analysis of the Species Likely to be Affected

The proposed action has the potential to adversely affect wintering and migrating red knots and their habitat. Potential effects to red knots include direct loss of foraging and roosting habitat in the Action Area and in the updrift and downdrift portions of Ocean Isle Beach and Holden Beach, degradation of foraging habitat and destruction of the prey base from sand disposal, and attraction of predators due to food waste from the construction crew. Like the piping plover, red knots face predation by avian and mammalian predators that are present year-round on the migration and wintering grounds.

B. Environmental Baseline

1) Status of the Species within the Action Area

Data provided by the NCWRC for the BA indicate that red knots have been observed on Holden Beach and Ocean Isle Beach for decades. 200 red knots were reported in one survey on Ocean Isle Beach in 1986, while 112 were reported on Ocean Isle Beach in one survey in 2012. See **Table 13**.

Table 13. Number of red knot observations between 1986 and 2012 on Ocean Isle and Holden Beach.

Year	Number of Red Knot observations	
	Ocean Isle Beach	Holden Beach
1986	200	
2006	6	5
2009	11	
2011	23	15
2012	112	56

2) Factors Affecting the Species Environment within the Action Area

A number of recent and on-going beach disturbance activities have altered the proposed Action Area. **Table 3** (page 53) lists the most recent projects, within the past 5 years.

Pedestrian Use of the Beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from hotels, beachfront and nearby residences.

Sand nourishment: The beaches of Ocean Isle and Holden Beach are regularly nourished with sand from the Corps' CSDR project. Nourishment activities widen beaches, change their sedimentology and stratigraphy, alter coastal processes and often plug dune gaps and remove overwash areas.

Inlet dredging activities alter the sediment dynamics on adjacent shorelines and stabilize these dynamic environments; beach disposal of dredge material further alters the natural habitat adjacent to inlets. Estuarine dredging of navigational channels can alter water circulation patterns and sediment transport pathways, as well as increase the frequency and magnitude of boat wakes; sound-side sand or mud flats may be impacted by increased erosion rates as a result. The Corps has regularly dredged Shallotte Inlet every few years since 2001 as part of the Ocean Isle Coastal Storm Damage Reduction (CSDR), and the sediment has been disposed on Ocean Isle.

Beach scraping or bulldozing can artificially steepen beaches, stabilize dune scarps, plug dune gaps, and redistribute sediment distribution patterns. Artificial dune building, often a product of beach scraping, removes low-lying overwash areas and dune gaps. As chronic erosion catches up to structures throughout the Action Area, artificial dune systems are constructed and maintained to protect beachfront structures either by sand fencing or fill placement. Beach scraping or bulldozing has been frequent on North Carolina beaches in recent years, in response to storms and the continuing retreat of the shoreline with rising sea level. These activities primarily occur during the winter months. Artificial dune or berm systems have been constructed and maintained in several areas. These dunes make the artificial dune ridge function like a seawall that blocks natural beach retreat, evolution, and overwash.

Sandbags and revetments are vertical structures built parallel to the beach in front of buildings, roads, and other facilities to protect them from erosion. However, these structures often accelerate erosion by causing scouring in front of and downdrift from the structure (Hayes and Michel 2008), which can eliminate red knot habitat. Geotubes (long cylindrical bags made of high-strength permeable fabric and filled with sand) and sandbag revetments are softer alternatives, but act as barriers by preventing overwash. There are two existing rock revetments along the coast of North Carolina: one at Fort Fisher (approximately 3,040 lf), and another along Carolina Beach (approximately 2,050 lf). Sandbags and sandbag revetments have been placed along at least 1,400 lf of the Action Area on Ocean Isle Beach. A sandbag revetment at least 1,500 lf long was constructed in 2015 at the north end of North Topsail Beach.

C. Effects of the Action

This section is an analysis of the beneficial, direct and indirect effects of the proposed action on migrating and wintering red knots within the Action Area. The analysis includes effects interrelated and interdependent of the project activities. An interrelated activity is an activity that is part of a proposed action and depends on the proposed activity. An interdependent activity is an activity that has no independent utility apart from the action.

1) Factors to be Considered

The proposed project will occur within habitat used by migrating and wintering red knots and construction will occur during a portion of the migration and winter seasons. Long-term and permanent impacts could preclude the creation of new habitat and increase recreational disturbance. Short-term and temporary impacts to red knots could result from project work disturbing roosting red knots and degrading currently occupied foraging areas.

Proximity of action: Beach renourishment and groin installation will occur within and adjacent to red knot roosting and foraging habitat.

Distribution: Project construction activities that may impact migrants and the wintering population of red knots on Ocean Isle and Holden Beach would occur along the shoreline on the east end of Ocean Isle and the west end of Holden Beach.

Timing: The timing of project construction could directly and indirectly impact migrating and wintering red knots.

Nature of the effect: The effects of the project construction include a temporary or permanent reduction in foraging habitat, a long term decreased rate of change that may preclude habitat creation, and increased recreational disturbance. A decrease in the survival of red knots on the migration and winter grounds due to the lack of optimal habitat may contribute to decreased survival rates, decreased productivity on the breeding grounds, and increased vulnerability to the population.

Duration: Groin installation will be a one-time activity, which will take up to 4 ½ months to complete. Sand fillet maintenance will be a recurring activity and will take up to 10 weeks to complete each time. Thus, the direct effects would be expected to be short-term in duration. Indirect effects from the activity may continue to impact migrating and wintering red knots in subsequent seasons after sand placement.

Disturbance frequency: Disturbance from construction activities will be short term, lasting up to 4 ½ months. Disturbance from maintenance of the sand fillet can be anticipated every 5 years for the life of the project. Recreational disturbance may increase after project completion and have long-term impacts.

Disturbance intensity and severity: Project construction is anticipated to be conducted during portions of the red knot migration and winter seasons. Conservation measures have been incorporated into the project to minimize impacts.

2) Analyses for Effects of the Action

Beneficial effects: For some highly eroded beaches, sand placement may have a beneficial effect on the habitat's ability to support wintering or migrating red knots. The addition of sand to the sediment budget may increase a sand-starved beach's likelihood of developing habitat features valued by red knots.

Direct effects: Direct effects are those direct or immediate effects of a project on the species or its habitat. The construction window (i.e., sand placement and groin installation) will extend into one or more red knot migration and winter seasons. Heavy machinery and equipment (e.g., trucks and bulldozers operating on Action Area beaches, the placement of the dredge pipeline along the beach, and sand disposal) may adversely affect migrating and wintering red knots in the Action Area by disturbance and disruption of normal activities such as roosting and foraging, and possibly forcing birds to expend valuable energy reserves to seek available habitat elsewhere.

Burial and suffocation of invertebrate species will occur during each sand fillet maintenance activity. Impacts will affect the 3,500 lf of shoreline. Timeframes projected for benthic recruitment and re-establishment following beach nourishment are between 6 months to 2 years. Depending on actual recovery rates, impacts will occur even if nourishment activities occur outside the red knot migration and wintering seasons.

Indirect effects: The proposed project includes beach renourishment and groin installation along 3,500 lf of shoreline as protective elements against shoreline erosion to protect man-made infrastructure. Indirect effects include reducing the potential for the formation of optimal habitats (coastal marine and estuarine habitats with large areas of exposed intertidal sediments) and erosion of foraging and resting habitat downdrift of the groin.

The proposed project may limit the creation of optimal foraging and roosting habitat, and may increase the attractiveness of these beaches for recreation increasing recreational pressures within the Action Area, including disturbance by unleashed pets and increased pedestrian use.

3) Species' Response to the Proposed Action

The proposed project will occur within habitat that is used by migrating and wintering red knots. Since red knots can be present on these beaches almost year-round, construction is likely to occur while this species is utilizing these beaches and associated habitats. Short-term and temporary impacts to red knot activities could result from project work occurring on the beach that flushes birds from roosting or foraging habitat. Long-term impacts could include a hindrance in the ability of migrating or wintering red knots to recuperate from their migratory flight from their breeding grounds, survive on their wintering areas, or to build fat reserves in preparation for migration. Long-term impacts may also result from changes in the physical characteristics of the beach from the placement of the groin and the sand.

D. Cumulative Effects

This project occurs on non-federal lands. Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion.

It is reasonable to expect continued shoreline stabilization and beach renourishment projects in this area in the future since erosion and sea-level rise increases would impact the existing beachfront development.

VII. SEABEACH AMARANTH

A. Status of the Species/Critical Habitat

1) Species/Critical Habitat Description

Seabeach amaranth (*Amaranthus pumilus*) is an annual plant that grows on Atlantic barrier islands and ocean beaches currently ranging from South Carolina to New York. It was listed as threatened under the Act on April 7, 1993 (58 FR 18035) because of its vulnerability to human and natural impacts and the fact that it had been eliminated from two-thirds of its historic range (USFWS 1996b). Seabeach amaranth stems are fleshy and pink-red or reddish, with small rounded leaves that are 0.5 to 1.0 inches in diameter. The green leaves, with indented veins, are clustered toward the tip of the stems, and have a small notch at the rounded tip. Flowers and fruits are relatively inconspicuous, borne in clusters along the stems. Seabeach amaranth will be considered for delisting when the species exists in at least six states within its historic range and when a minimum of 75 percent of the sites with suitable habitat within each state are occupied by populations for l0 consecutive years (USFWS 1996b). The recovery plan states that mechanisms must be in place to protect the plants from destructive habitat alterations, destruction or decimation by off-road vehicles or other beach uses, and protection of populations from debilitating webworm predation. There is no designation of critical habitat for seabeach amaranth.

2) Life History

Seabeach amaranth is an annual plant. Germination of seabeach amaranth seeds occurs over a relatively long period, generally from April to July. Upon germinating, this plant initially forms a small unbranched sprig, but soon begins to branch profusely into a clump. This clump often reaches one foot in diameter and consists of five to 20 branches. Occasionally, a clump may get as large as three feet or more across, with 100 or more branches. Flowering begins as soon as plants have reached sufficient size, sometimes as early as June, but more typically commencing in July and continuing until the death of the plant in late fall. Seed production begins in July or August and peaks in September during most years, but continues until the death of the plant. Weather events, including rainfall, hurricanes, and temperature extremes, and predation by webworms have strong effects on the length of the reproductive season of seabeach amaranth. Because of one or more of these influences, the flowering and fruiting period can be terminated as early as June or July. Under favorable circumstances, however, the reproductive season may extend until January or sometimes later (Radford et al. 1968; Bucher and Weakley 1990; Weakley and Bucher1992).

3) Population Dynamics

Within North Carolina and across its range, seabeach amaranth numbers vary from year to year. Data in North Carolina is available from 1987 to 2013. Recently, the number of plants across the entire state dwindled from a high of 19,978 in 2005 to 165 in 2013. This trend of decreasing numbers is seen throughout its range. 249,261 plants were found throughout the species' range in 2000. By 2013, those numbers had dwindled to 1,320 plants (USFWS, unpublished data).

Seabeach amaranth is dependent on natural coastal processes to create and maintain habitat. However, high tides and storm surges from tropical systems can overwash, bury, or inundate seabeach amaranth plants or seeds, and seed dispersal may be affected by strong storm events. In September of 1989, Hurricane Hugo struck the Atlantic Coast near Charleston, South Carolina, causing extensive flooding and erosion north to the Cape Fear region of North

Carolina, with less severe effects extending northward throughout the range of seabeach amaranth. This was followed by several severe storms that, while not as significant as Hurricane Hugo, caused substantial erosion of many barrier islands in the seabeach amaranth's range. Surveys for seabeach amaranth revealed that the effects of these climatic events were substantial (Weakley and Bucher 1992). In the Carolinas, populations of amaranth were severely reduced. In South Carolina, where the effects of Hurricane Hugo and subsequent dune reconstruction were extensive, amaranth numbers declined from 1,800 in 1988 to I88 in 1990, a reduction of 90 percent. A 74 percent reduction in amaranth numbers occurred in North Carolina, from 41,851 plants in 1988 to 10,898 in 1990. Although population numbers in New York increased in 1990, range-wide totals of seabeach amaranth were reduced 76 percent from 1988 (Weakley and Bucher 1992). The extent stochastic events have on long-term population trends of seabeach amaranth has not been assessed.

4) Status and Distribution

The species historically occurred in nine states from Rhode Island to South Carolina (USFWS 2003c). By the late 1980s, habitat loss and other factors had reduced the range of this species to North and South Carolina. Since 1990, seabeach amaranth has reappeared in several states that had lost their populations in earlier decades. However, threats like habitat loss have not diminished, and populations are declining overall. It is currently found in New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, and South Carolina. The typical habitat where this species is found includes the lower foredunes and upper beach strands on the ocean side of the primary sand dunes and overwash flats at accreting spits or ends of barrier islands.

Seabeach amaranth has been and continues to be threatened by destruction or adverse alteration of its habitat. As a fugitive species dependent on a dynamic landscape and large-scale geophysical processes, it is extremely vulnerable to habitat fragmentation and isolation of small populations. Further, because this species is easily recognizable and accessible, it is vulnerable to taking, vandalism, and the incidental trampling by curiosity seekers. Seabeach amaranth is afforded legal protection in North Carolina by the General Statutes of North Carolina, Sections 106-202.15, 106- 202.19 (N.C. Gen. Stat. section 106 (Supp. 1991)), which provide for protection from intrastate trade (without a permit).

The most serious threats to the continued existence of seabeach amaranth are construction of beach stabilization structures, natural and man-induced beach erosion and tidal inundation, fungi (i.e., white wilt), beach grooming, herbivory by insects and mammals, and off-road vehicles. Herbivory by webworms, deer, feral horses, and rabbits is a major source of mortality and lowered fecundity for seabeach amaranth. However, the extent to which herbivory affects the species as a whole is unknown.

Potential effects to seabeach amaranth from vehicle use on the beaches include vehicles running over, crushing, burying, or breaking plants, burying seeds, degrading habitat through compaction of sand and the formation of seed sinks caused by tire ruts. Seed sinks occur when blowing seeds fall into tire ruts, then a vehicle comes along and buries them further into the sand preventing germination. If seeds are capable of germinating in the tire ruts, the plants are usually destroyed before they can reproduce by other vehicles following the tire ruts. Those seeds and their reproductive potential become lost from the population.

Pedestrians also can negatively affect seabeach amaranth plants. Seabeach amaranth occurs on the upper portion of the beach which is often traversed by pedestrians walking from parking lots, hotels, or vacation property to the ocean. This is also the area where beach chairs and umbrellas are often set up and/or stored. In addition, resorts, hotels, or other vacation rental establishments may set up volleyball courts or other sporting activity areas on the upper beach at the edge of the dunes. All of these activities can result in the trampling and destruction of plants. Pedestrians walking their dogs on the upper part of the beach, or dogs running freely on the upper part of the beach, may result in the trampling and destruction of seabeach amaranth plants.
The extent of the effects that dogs have on seabeach amaranth is not known.

Recovery Criteria

Delisting of seabeach amaranth will be considered when a minimum of 75 percent of the sites with suitable habitat within at least six of the nine historically occupied States are occupied by seabeach amaranth populations for 10 consecutive years.

5) Analysis of the Species Likely to be Affected

The predominant threat to seabeach amaranth is the destruction or alteration of suitable habitat, primarily because of beach stabilization efforts and storm-related erosion (USFWS 1993). Other important threats to the plant include beach grooming and vehicular traffic, which can easily break or crush the fleshy plant and bury seeds below depths from which they can germinate; and predation by webworms (caterpillars of small moths) (USFWS 1993). Webworms feed on the leaves of the plant and can defoliate the plants to the point of either killing them or at least reducing their seed production. Beach vitex (*Vitex rotundifulia*) is another threat to seabeach amaranth, as it is an aggressive, invasive, woody plant that can occupy habitat similar to seabeach amaranth and outcompete it (Invasive Species Specialist Group (ISSG) 2010).

The proposed action has the potential to adversely affect seabeach amaranth within the proposed Action Area. Potential effects include burying, trampling, or injuring plants as a result of construction operations and/or sediment disposal activities; burying seeds to a depth that would prevent future germination as a result of construction operations and/or sediment disposal activities; and, destruction of plants by trampling or breaking as a result of increased recreational activities. The Applicant proposes to construct the groin and place sand between November 16 and April 30. However, given favorable weather, seabeach amaranth plants may persist until January. Therefore, there is still the potential for sand placement to adversely impact plants in the Action Area.

B. Environmental Baseline

1) Status of the Species within the Action Area

Since 1992, seabeach amaranth surveys have been conducted on Ocean Isle and Holden Beach. The numbers of seabeach amaranth vary widely from year to year. On Holden Beach, the numbers vary from 1 individual in 1997 to 1954 individuals in 2006. On Ocean Isle Beach, the numbers vary from 1 individual in 2012 and 2013 to 819 in 1996. See **Table 14** for data from the Corps.

Table 14. Annual seabeach amaranth results on Ocean Isle and Holden Beach, NC between 1992 and 2013.

Year	Number of Seabeach Amaranth	
	Ocean Isle	Holden Beach
1992	5	21
1993	15	52
1994	112	239
1995	22	59
1996	819	99
1997	7	1
1998	11	32
1999	5	268
2000	4	10
2001	5	223
2002	45	702
2003	206	843
2004	49	79
2005	545	800
2006	337	1954
2007	20	281
2008	110	574
2009	36	123
2010	4	434
2011	5	116
2012	1	46
2013	1	108

2) Factors Affecting the Species Environment within the Action Area

A number of recent and on-going beach disturbance activities have altered the proposed Action Area. **Table 3** (page 53) lists the most recent projects, within the past 5 years.

Pedestrian Use of the Beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from hotels, beachfront and nearby residences.

Sand nourishment: The beaches of Ocean Isle and Holden Beach are regularly nourished with sand from the Corps' Federal CSDR project.

Shoreline stabilization: Approximately 1,400 lf of the Action Area has been stabilized with sandbags.

C. Effects of the Action

1) Factors to be Considered

Proximity of action: Beach renourishment and groin installation will occur within and adjacent to seabeach amaranth habitat.

Distribution: Project construction activities that may affect seabeach amaranth plants on Ocean Isle would occur along the eastern shoreline of the island.

Timing: The timing of project construction could directly and indirectly impact seabeach amaranth.

Nature of the effect: The effects of the project construction include burying, trampling, or injuring plants as a result of construction operations and/or sediment disposal activities; burying seeds to a depth that would prevent future germination as a result of construction operations and/or sediment disposal activities; and, destruction of plants by trampling or breaking as a result of increased recreational activities.

Duration: Groin installation will be a one-time activity, which will take up to 4 ½ months to complete. Sand fillet maintenance will be a recurring activity and will take up to 10 weeks to complete each time. Thus, the direct effects would be expected to be short-term in duration. Indirect effects from the activity may continue to impact seabeach amaranth in subsequent seasons after sand placement.

Disturbance frequency: Disturbance from the initial construction activities will be short term, lasting up to 4 ½ months. Disturbance from maintenance of the sand fillet can be anticipated every 5 years for the life of the project. Recreational disturbance may increase after project completion and have long-term impacts.

Disturbance intensity and severity: Project construction is anticipated to be conducted during portions of the seabeach amaranth growing and flowering season. Conservation measures have been incorporated into the project to minimize impacts.

2) Analyses for Effects of the Action

Beneficial Effects: The placement beach-compatible sand may benefit this species by providing additional suitable habitat or by redistributing seed sources buried during past storm events, beach disposal activities, or natural barrier island migration. Disposal of dredged sand may be compatible with seabeach amaranth provided the timing of beach disposal is appropriate, the material placed on the beach is compatible with the natural sand, and special precautions are adopted to protect existing seabeach amaranth plants. Further studies are needed to determine the best methods of beach disposal in seabeach amaranth habitat (Weakley and Bucher 1992).

Direct Effects: Groin construction and sand placement activities may bury or destroy existing plants, resulting in mortality, or bury seeds to a depth that would prevent future germination, resulting in reduced plant populations. Increased traffic from recreationists and their pets can also destroy existing plants by trampling or breaking the plants.

Indirect Effects: Future tilling of the beach may be necessary if beach compaction hinders sea turtle nesting activities. Thus, the placement of heavy machinery or associated tilling equipment on the beach may destroy or bury existing plants.

3) Species' Response to the Proposed Action

The construction of the groin and placement of sand in the Action Area could bury existing plants if work is conducted during the growing season. Sand placement at any time of year could also bury seeds to a depth that would prevent germination.

Sand placement beaches could also have positive impacts on seabeach amaranth by creating additional habitat for the species. Although more study is needed before the long-term impacts can be accurately assessed, several populations are shown to have established themselves on beaches receiving dredged sediments, and have thrived through subsequent applications of dredged material (Weakley and Bucher 1992).

D. Cumulative Effects

This project occurs on non-federal lands. Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion.

It is reasonable to expect continued shoreline stabilization and beach renourishment projects in this area in the future since erosion and sea-level rise increases would impact the existing beachfront development.

VIII. CONCLUSION

Sea Turtles

After reviewing the current status of the nesting loggerhead sea turtle, green sea turtle, leatherback sea turtle, and Kemp's ridley sea turtle, the environmental baseline for the Action Area, the effects of the proposed sand placement and groin construction, the proposed Conservation Measures, and the cumulative effects, it is the Service's biological opinion that the placement of sand and construction and presence of the groin as proposed, is not likely to jeopardize the continued existence of the loggerhead sea turtle, green sea turtle, leatherback sea turtle, and Kemp's ridley sea turtle. The Service has determined that the project is not likely to destroy or adversely modify designated critical habitat for nesting loggerhead sea turtles.

The conservation of the five loggerhead recovery units in the Northwest Atlantic is essential to the recovery of the loggerhead sea turtle. Each individual recovery unit is necessary to conserve genetic and demographic robustness, or other features necessary for long-term sustainability of the entire population. Thus, maintenance of viable nesting in each recovery unit contributes to the overall population. The NRU, one of the five loggerhead recovery units in the Northwest Atlantic occurs within the Action Area. The NRU averages 5,215 nests per year (based on 1989-2008 nesting data). Of the available nesting habitat within the NRU, construction will occur and/or will likely have an effect on 24,500 lf of nesting shoreline.

Generally, green, leatherback, and Kemp's ridley sea turtle nesting overlaps with or occurs within the beaches where loggerhead sea turtles nest on both the Atlantic and Gulf of Mexico beaches. Thus, for green, leatherback, and Kemp's ridley sea turtles, dredging and sand placement activities will affect 24,500 lf of shoreline.

Long-term adverse effects to adult and hatchling sea turtles are anticipated as a result of the presence of the groin. The permanent placement of the groin is expected to affect nesting, hatching, and hatchling emerging success within that area for the life of the structure. Although a variety of factors, including some that cannot be controlled, can influence how an erosion control structure construction project will perform from an engineering perspective, measures can be implemented to minimize adverse impacts to sea turtles. Take of sea turtles will be minimized by implementation of the Reasonable and Prudent Measures, and Terms and Conditions outline below. These measures have been shown to help minimize adverse impacts to sea turtles.

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

Piping Plovers

Construction will occur and/or will likely have an effect on 24,500 lf of shoreline. After reviewing the current status of the northern Great Plains, Great Lakes, and Atlantic Coast wintering piping plover populations, the environmental baseline for the Action Area, the effects of the proposed activities, the proposed Conservation Measures, and the cumulative effects, it is the Service's biological opinion that implementation of these actions, as proposed, is not likely to jeopardize the continued existence of the piping plover.

Red Knot

Construction will occur and/or will likely have an effect on 24,500 lf of shoreline. After reviewing the current status of the migrating and wintering red knot populations, the environmental baseline for the Action Area, the effects of the proposed activities, the proposed Conservation Measures, and the cumulative effects, it is the Service's biological opinion that implementation of these actions, as proposed, is not likely to jeopardize the continued existence of the red knot.

Seabeach Amaranth

Construction will occur and/or will likely have an effect on 24,500 lf of shoreline. After reviewing the current status of the seabeach amaranth population, the environmental baseline for the Action Area, the effects of the proposed activities, the proposed Conservation Measures, and the cumulative effects, it is the Service's biological opinion that implementation of these actions, as proposed, is not likely to jeopardize the continued existence of the seabeach amaranth.

INCIDENTAL TAKE STATEMENT

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

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

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of state law or regulation, or in the course of any violation of a State criminal trespass law.

AMOUNT OR EXTENT OF TAKE

Amount of Extent of Take – Loggerhead, Green, Leatherback, and Kemp's Ridley Sea Turtles

The Service anticipates 24,500 lf of nesting beach habitat could be taken as a result of this proposed action. Take is expected to be in the form of: (1) Destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey and nest mark and avoidance program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey and nest mark and avoidance program is not required to be in place within the boundaries of the proposed project; (3) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (4) misdirection of nesting sea turtles or hatchling turtles on beaches within the boundaries of the proposed project or beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of increased sand accretion due to the presence of the groin or jetty; (5) behavior modification of nesting females due to escarpment formation, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; (6) destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Service; (7) behavior modification of nesting females or hatchlings due to the presence of the groin which may act as a barrier to movement or cause disorientation of turtles while on the nesting beach; (8) physical entrapment of hatchling sea turtles on the nesting beach due to the presence of the groin; behavior modification of nesting females if they dig above a buried portion of the structure, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas; and (9) obstructed or entrapped an unknown number of adult and hatchling sea turtles during ingress or egress at nesting sites.

Incidental take is anticipated for only the 24,500 lf of beach that has been identified. The Service anticipates incidental take of sea turtles will be difficult to detect for the following reasons: (1) the turtles nest primarily at night and all nests are not found because [a] natural factors, such as rainfall, wind, and tides may obscure crawls and [b] human-caused factors, such as pedestrian and vehicular traffic, may obscure crawls, and result in nests being destroyed because they were missed during a nesting survey and nest mark and avoidance program (2) the total number of hatchlings per undiscovered nest is unknown; (3) an unknown number of females may avoid the project beach and be forced to nest in a less than optimal area; (5) lights may misdirect an unknown number of hatchlings and cause death; (6) an unknown number of adult and hatchling sea turtles may be obstructed or entrapped during ingress or egress at nesting sites; and (7) escarpments may form and prevent an unknown number of females from accessing a suitable nesting site. However, the level of take of these species can be anticipated by the construction and presence of the groin and sand placement on suitable turtle nesting beach habitat because: (1) turtles nest within the project site; (2) the groin construction project will modify beach profile and width and increase the presence of escarpments; (3) the renourishment project will modify the incubation substrate, beach slope, and sand compaction; and (4) artificial lighting will deter and/or misdirect nesting hatchling turtles.

Amount or Extent of Take – Piping Plover and Red Knot

It is difficult for the Service to estimate the exact number of piping plovers and red knots that could be migrating through or wintering within the Action Area at any one point in time and place during project construction. Disturbance to suitable habitat resulting from both construction and sand placement activities within the Action Area would affect the ability of an undetermined number of piping plovers and red knots to find suitable foraging and roosting habitat during any given year.

The Service anticipates that directly and indirectly an unspecified amount of piping plovers and red knots along 24,500 lf of shoreline, all at some point, potentially usable by piping plovers and red knots, could be taken in the form of harm and harassment as a result of this proposed action; however, incidental take of piping plovers and red knots will be difficult to detect for the following reasons:

(1) harassment to the level of harm may only be apparent on the breeding grounds the following year; and
(2) dead plovers and red knots may be carried away by waves or predators.

The level of take of this species can be anticipated by the proposed activities because:

(1) piping plovers and red knots migrate through and winter in the Action Area;
(2) the placement of the constructed beach is expected to affect the coastal morphology and prevent early successional stages, thereby precluding the maintenance and creation of additional recovery habitat;
(3) increased levels of pedestrian disturbance may be expected; and
(4) a temporary reduction of food base will occur.

The Service has reviewed the biological information and other information relevant to this action. The take is expected in the form of harm and harassment because of: (1) decreased fitness and survivorship of plovers and red knots due to loss and degradation of foraging and roosting habitat; (2) decreased fitness and survivorship of plovers and red knots attempting to migrate to breeding grounds due to loss and degradation of foraging and roosting habitat; and (3) decreased fitness and survivorship of piping plovers attempting to nest in the Action Area.

EFFECT OF THE TAKE

Sea Turtles

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the loggerhead sea turtle, green sea turtle, leatherback sea turtle, and Kemp's ridley sea turtle species. The Service has determined that the proposed project will not result in destruction or adverse modification of designated critical habitat for the loggerhead sea turtle.

Incidental take of nesting and hatchling sea turtles is anticipated to occur during project construction and during the life of the project. Take will occur on nesting habitat on 24,500 lf of shoreline.

Piping Plovers

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the piping plover species. The Service has determined that the proposed project will not result in destruction or adverse modification of critical habitat for the piping plover. Incidental take of piping plovers is anticipated to occur along 24,500 lf of shoreline.

Red Knot

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the red knot species. Incidental take of red knots is anticipated to occur along 24,500 lf of shoreline.

Seabeach Amaranth

In the accompanying biological opinion, the Service determined that the potential of the project to damage or destroy seabeach amaranth is not likely to result in jeopardy to the seabeach amaranth species. Damage or destruction of seabeach amaranth plants is anticipated to occur along approximately 24,500 feet of shoreline.

IX. REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize take of loggerhead sea turtles, green sea turtles, leatherback sea turtles, Kemp's ridley sea turtles, piping plovers, red knots, and seabeach amaranth. Unless specifically addressed below, these RPMs are applicable for the construction of the terminal groin and for any maintenance activities for the life of the permit. If the Applicant is unable to comply with the RPMs and Terms and Conditions, the Corps as the regulatory authority may inform the Service why the RPM or Term and Condition is not reasonable and prudent for the specific project or activity and request exception under the biological opinion.

RPMs – All Species

1. All derelict material or other debris must be removed from the beach prior to any construction.

2. Conservation Measures included in the permit application/project plans must be implemented in the proposed project. If a RPM and Term and Condition address the same requirement, the requirements of the RPM and Term and Condition take precedent over the Conservation Measure. This includes the timing of the proposed project to avoid the sea turtle nesting season, to reduce the possibility of sea turtle nest burial, crushing of eggs, or nest excavation.

3. Predator-proof trash receptacles must be installed and maintained at all beach access points used for the initial project construction and all maintenance events, to minimize the potential for attracting predators of sea turtles, piping plovers, and red knots.

4. A meeting between representatives of the Applicant's contractor, Corps, Service, NCWRC, the permitted sea turtle surveyor, bird and other species surveyors, as appropriate, must be held prior to the commencement of construction of the terminal groin.

5. In the event the terminal groin structure begins to disintegrate, all debris and structural material must be removed.

6. The Applicant or Corps must submit all reports produced pursuant to the Inlet Management Plan (referenced in the revisions to North Carolina General Statute 113A-115.1(e)(5)) to the Service's Raleigh Field Office, within 30 days of completion of each report.

7. The groin must be removed or modified if it is determined to not be effective as determined pursuant to the Inlet Management Plan listed above, or if it is determined to be causing a significant adverse impact to the beach and dune system.

8. During construction of the terminal groin, and for the life of the permit, all sand placement activities to maintain the sand fillet must be conducted within the winter work window (November 16 to April 30), unless necessitated by an emergency condition and allowed after consultation with the Service.

9. The pipeline placement must be coordinated with the Corps, the Raleigh Field Office, and the NCWRC.

RPMs – Loggerhead, Green, Leatherback, and Kemp's Ridley Sea Turtle

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of loggerhead, green, Kemp's ridley, and leatherback sea turtles:

1. Beach compatible sand suitable for sea turtle nesting, successful incubation, and hatchling emergence must be used on the project site for initial groin construction and all maintenance events.

2. No construction shall be conducted during the nesting season and hatching season from May 1 through November 15.

3. No permanent exterior lighting will be installed in association with this construction project, unless required by the U.S. Coast Guard. Temporary lighting will be allowed if safety lighting is required at any excavated trenches that must remain on the beach at night.

4. If the construction of the groin will be conducted during the period from April 15 to April 30, daily early morning surveys for early nesting sea turtles must be conducted. If the construction project will be conducted during the period from November 16 through November 30, surveys for late nesting sea turtles must be conducted. If nests are laid in the area of construction, the nests must be marked and avoided. Nesting surveys and nest marking must be initiated 65 days prior to construction activities or by April 15, whichever is later.

5. Visual surveys for escarpments along the Action Area must be made following completion of the terminal groin and any sand maintenance events, and also prior to May 1 for two subsequent years (after sand is placed on the beach). Escarpment formation must be monitored and leveling must be conducted if needed to reduce the likelihood of impacting nesting and hatchling sea turtles.

6. Staging areas for earth-moving equipment must be located off the beach during the early (April 15 through April 30) and late (November 16 through November 30) portions of the nesting season. Nighttime storage of earth-moving equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. All

excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day.

7. Sand compaction must be monitored in the area of sand placement immediately after completion of the project, after any future sand maintenance events, and also prior to May 1 for two subsequent years after sand is placed on the beach.

8. Daily sea turtle nesting surveys must be conducted by the Applicant or Corps for three nesting seasons following construction of the groin or sand maintenance events, if the groin remains on the beach. All nests from a point 3,200 feet west (updrift) of the groin (at approximately Highpoint Street) to a point 2,000 feet east (downdrift) of the groin must be marked for three (3) years post-construction. These nests must be monitored daily until the end of incubation to determine whether those nests are eroded and whether the groin is a potential barrier to hatchlings moving off the beach and through the surf zone. If the groin is found to be an obstruction, Corps will notify NCWRC and the Service immediately for remedial action.

9. A report describing the fate of the nests and hatchlings and any actions taken, must be submitted to the Service following completion of the proposed work for each year when an activity has occurred (such as sand placement).

10. A post-construction survey of all artificial lighting visible from the adjacent beach (1,000 lf on either side of the groin) must be completed by the Applicant or Corps to determine if sand accretion caused by the groin created an increased impact due to artificial lighting within the vicinity of the groin structures.

RPMs – Piping Plover and Red Knot

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of piping plovers and red knots:

1. All personnel involved in the construction or sand placement process along the beach shall be trained to recognize the presence of piping plovers and red knots prior to initiation of work on the beach. Before start of work each morning, a visual survey must be conducted along the ingress routes and in the area of work for that day, to determine if piping plovers or red knots are present.

2. A bird monitoring plan must be developed to monitor piping plover, red knot, waterbirds, colonial waterbirds and other shorebirds in the Shallotte Inlet area during and after

construction. Monitoring must be conducted for a minimum of three (3) full years past the completion of groin construction, or until the end of the shorebird nesting season (August 31) of the third year, whichever is later.

RPM – Seabeach Amaranth

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of seabeach amaranth:

1. Seabeach amaranth surveys must be conducted in the Action Area for a minimum of three years after completion of construction.

X. TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Unless addressed specifically below, the terms and conditions are applicable for the construction of the terminal groin and for any maintenance activities for the life of the permit.

Terms and Conditions – All Species

1. All derelict coastal armoring geotextile material and other debris must be removed from the beach prior to any sand placement or construction to the maximum extent possible.

2. Conservation Measures included in the permit application/project plans must be implemented in the proposed project. If a RPM and Term and Condition address the same requirement, the requirements of the RPM and Term and Condition take precedent over the Conservation Measure. This includes the timing of the proposed project to avoid the sea turtle nesting season, to reduce the possibility of sea turtle nest burial, crushing of eggs, or nest excavation.

3. Predator-proof trash receptacles must be installed and maintained during construction at all beach access points used for the project construction and sand maintenance events, to minimize the potential for attracting predators of sea turtles, piping plovers, and red knots. All contractors conducting the work must provide predator-proof trash receptacles for the construction workers. All contractors and their employees must be briefed on the importance of not littering and keeping the Action Area free of trash and debris. See **Appendix A** for examples of suitable receptacles.

4. A meeting between representatives of the contractor, the Service, NCWRC, the permitted sea turtle surveyor, bird and other species surveyors, as appropriate, must be held prior to the commencement of construction of the terminal groin. At least 10 business days advance notice must be provided prior to conducting this meeting. The meeting will provide an opportunity for explanation and/or clarification of the required measures in the BO, as well as follow-up meetings during construction.

5. In the event the structure begins to disintegrate, all debris and structural material must be removed from the nesting beach area and deposited off-site immediately upon coordination with the Service. If removal of the structure is required during the period from May 1 to November 15, no work will be initiated without prior coordination with the Corps and the Service.

6. The Applicant or Corps must submit all reports produced pursuant to the Inlet Management Plan (referenced in the revisions to North Carolina General Statute 113A-115.1(e)(5)) to the Service's Raleigh Field Office, within 30 days of completion of each report.

7. The groin must be removed or modified if it is determined to not be effective as determined by the Inlet Management Plan referred to above, or if it is determined to be causing a significant adverse impact to the beach and dune system.

8. During construction of the terminal groin, and for the life of the permit, all sand placement activities to maintain the sand fillet must be conducted within the winter work window (November 16 to April 30), unless necessitated by an emergency condition and allowed after consultation with the Service.

9. The pipeline placement must be coordinated with the Corps, the Raleigh Field Office, and the NCWRC.

Terms and Conditions – Loggerhead, Green, Kemp's ridley, and Leatherback Sea Turtle

1. Beach compatible fill must be placed on the beach or in any associated dune system. Beach compatible fill must be sand that is similar to a native beach in the vicinity of the site that has not been affected by prior sand placement activity. Beach compatible fill must be sand solely of natural sediment and shell material, containing no construction debris, toxic material, large amounts of rock, or other foreign matter. The beach compatible fill must be similar in both color and grain size distribution (sand grain frequency, mean and median grain size and sorting coefficient) to the native material in

the Action Area. Beach compatible fill is material that maintains the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system. In general, fill material that meets the requirements of the North Carolina Technical Standards for Beach Fill (15A NCAC 07H .0312) is considered compatible.

2. During the nesting season (May 1 through November 15), no construction will be allowed on the beach, and no equipment may be placed and/or stored on the beach.

3. No permanent exterior lighting will be installed in association with this construction project, unless required by the U.S. Coast Guard. Temporary lighting will be allowed if safety lighting is required at any excavated trenches that must remain on the beach at night.

4. If the construction of the groin will be conducted during the period from April 15 to April 30, daily early morning surveys for early nesting sea turtles must be conducted. If the construction project will be conducted during the period from November 16 through November 30, surveys for late nesting sea turtles must be conducted. If nests are laid in the area of construction, the nests must be marked and avoided. Nesting surveys and nest marking must be initiated 65 days prior to construction activities or by April 15, whichever is later.

5. Visual surveys for escarpments along the Action Area must be made immediately after completion of construction, after sand maintenance events, and within 30 days prior to May 1 for two subsequent years after any construction or sand placement event. Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet must be leveled and the beach profile must be reconfigured to minimize scarp formation by the dates listed above. Any escarpment removal must be reported by location. The Service must be contacted immediately if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service or NCWRC will provide a brief written authorization within 30 days that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken must be submitted to the Service's Raleigh Field Office.

6. Staging areas for earth-moving equipment must be located off the beach during the early (April 15 through April 30) and late (November 16 through November 30) portions of the nesting season. Nighttime storage of earth-moving equipment not in use must be off the

beach to minimize disturbance to sea turtle nesting and hatching activities. All excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day. During any periods when excavated trenches must remain on the beach at night, nighttime sea turtle monitoring by the sea turtle permit holder will be required in the project area in order to further reduce possible impacts to nesting and hatchling sea turtles. Nighttime monitors will record data on false crawls, successful nesting, and any additional activities of nesting or hatchling sea turtles in the project area.

7. Sand compaction must be monitored in the area of sand placement immediately after completion of the construction, after any sand maintenance event, and also prior to May 1 for two subsequent years after any construction or sand placement event. Out-year compaction monitoring and remediation are not required if the placed material no longer remains on the dry beach.
   h. Within 7 days of completion of sand placement and prior to any tilling, a field meeting shall be held with the Service, NCWRC, and the Corps to inspect the Action Area for compaction, and determine whether tilling is needed.
   i. If tilling is needed, the area must be tilled to a depth of 36 inches.
   j. All tilling activity shall be completed prior to May 1.
   k. Tilling must occur landward of the wrack line and avoid all vegetated areas that are 3 square feet (sf) or greater, with a 3 sf buffer around the vegetated areas.
   l. If tilling occurs during shorebird nesting season (after April 1), shorebird surveys are required prior to tilling per the Migratory Bird Treaty Act.
   m. A report on the results of compaction monitoring will be submitted to the Raleigh Field Office and NCWRC prior to any tilling actions being taken. An annual summary of compaction assessments and the actions taken will be submitted to the Service, as required in REPORTING REQUIREMENTS, below.
   n. This condition will be evaluated annually and may be modified if necessary to address sand compaction problems identified during the previous year.

8. Daily sea turtle nesting surveys must be conducted by the Applicant or Corps for three (3) full nesting seasons following construction if the groin structure remains in place. All nests from a point 3,200 feet west (updrift) of the groin (at approximately High Point Street) to a point 2,000 feet east (downdrift) of the groin must be marked for three (3) years post-construction. The survey area must be divided into three segments: Updrift Zone, Project Zone, and Downdrift Zone. The parameters listed in **Appendix B** shall be recorded for each crawl encountered on a daily survey. In addition, any obstructions (natural or man-made) encountered by the turtle and the turtle's response to that obstruction must be reported. These nests must be monitored daily till the end of

hatching to determine whether those nests are eroded and whether the groin is a potential barrier to hatchlings moving off the beach and through the surf zone. This information will be provided to the Raleigh Field Office pursuant to the REPORTING REQUIREMENTS section, below, and will be used to periodically assess the cumulative effects of these projects on sea turtle nesting and hatchling production and monitor suitability for nesting. The Corps will notify the NCWRC and the Service immediately for remedial action.

9. A report describing the fate of sea turtle nests and hatchlings and any actions taken, must be submitted to the Raleigh Field Office following completion of the proposed work for each year when an activity has occurred (e.g. sand placement or groin construction). Please see REPORTING REQUIREMENTS below, for more information.

10. A post construction survey(s) of all artificial lighting visible from the adjacent beach (100 feet on either side of the groin must be completed by the Applicant or Corps. Two surveys must be conducted of all lighting visible from the construction area by the Applicant or the Corps, using standard techniques for such a survey (**Appendix C**), in the year following construction. The first survey must be conducted between May 1 and May 15 and a brief summary provided to the Raleigh Field Office. The second survey must be conducted between July 15 and August 1. A summary report of the surveys, (include the following information: methodology of the survey, a map showing the position of the lights visible from the beach, a description of each light source visible from the beach, recommendations for remediation, and any actions taken), must be submitted to the Raleigh Field Office within 3 months after the last survey is conducted. After the annual report is completed, a meeting must be set up with the Applicant, county or municipality, NCWRC, Corps, and the Service to discuss the survey report, as well as any documented sea turtle disorientations in or adjacent to the project area.

Terms and Conditions – Piping Plover and Red Knot

1. All personnel involved in the construction or sand placement process along the beach shall be trained to recognize the presence of piping plovers and red knots prior to initiation of work on the beach. Before start of work each morning, a visual survey must be conducted along the ingress route and in the area of work for that day, to determine if piping plovers or red knots are present. If plovers or red knots are present in the work area, careful movement of equipment in the early morning hours should allow those individuals to move out of the area. If piping plovers or red knots are observed, the observer shall make a note on the Quality Assurance form for that day, and submit the information to the Corps and the Service's Raleigh Field Office the following day.

2. A bird monitoring plan must be developed to monitor piping plover, red knot, waterbirds, colonial waterbirds and other shorebirds during and after construction. Monitoring must be conducted for a minimum of three (3) full years past the completion of groin construction, or until the end of the shorebird nesting season (August 31) of the third year after construction, whichever is later. Post-construction monitoring may only be ceased after the review of at least three years' worth of data and approval by the Corps, Service, NCDCM, and NCWRC.
    e. The bird monitoring plan, including methods and a figure showing the proposed locations and extent of monitoring, must be submitted for review and approval to the Corps, Service, NCDCM, and NCWRC, at least 60 days prior to the anticipated start of construction.
    f. During construction, bird monitoring must be conducted weekly. For at least three years after construction is completed, bimonthly (twice-monthly) bird surveys shall be conducted in all intertidal and shoreline areas from a point 3,200 lf west (updrift) of the groin (at approximately Highpoint Street) to a point just west of Skimmer Court on Holden Beach. All intertidal and supratidal unvegetated areas of the oceanfront, inlet shoulders, and sandy shoreline along the AIWW (in the vicinity of Shallotte Inlet and piping plover critical habitat unit NC-17) must be included. Field observations must be conducted during daylight hours, and primarily during high tide.
    g. Shorebird identification, especially when in non-breeding plumage, can be difficult. The person(s) conducting the survey must demonstrate the qualifications and ability to identify shorebird species and be able to provide the information listed below. The bird monitoring plan should include the collection and reporting of the following:
        i. Date, location, time of day, weather, and tide cycle when survey was conducted;
        ii. Latitude and longitude of observed piping plover and red knot locations (decimal degrees preferred);
        iii. Any color bands observed on piping plovers or red knots or other birds;
        iv. Behavior (e.g., foraging, roosting, preening, bathing, flying, aggression, walking, courtship, copulation);
        v. Landscape features(s) where birds are located (e.g., inlet spit, tidal creeks, shoals, lagoon shoreline);
        vi. Habitat features(s) used by birds when observed (e.g., intertidal, fresh wrack, old wrack, dune, mid-beach, vegetation);
        vii. Substrata used by birds (e.g., sand, mud/sand, mud, algal mat); and
        viii. The amount and type of recreational use (e.g., people, dogs on or off leash, vehicles, kite-boarders).

h. All monitoring information shall be provided in standardized form on an Excel spreadsheet. Monitoring results shall be submitted (datasheets, maps, database) on standard electronic media (e.g., CD, DVD) to the Raleigh Field Office. Please see REPORTING REQUIREMENTS below, for more information.

Terms and Conditions – Seabeach Amaranth

1. Seabeach amaranth surveys must be conducted updrift and downdrift of the terminal groin in the Action Area, from a point 3,200 lf west of the groin (at approximately Highpoint Street) along Ocean Isle Beach to a point 2,000 lf east of the groin, for a minimum of three years after completion of groin construction. Surveys should be conducted in August of each year. Habitat known to support this species, including the upper edges of the beach, lower foredunes, and overwash flats must be visually surveyed for the plant. Annual reports should include numbers of plants, latitude/longitude, and habitat type. Please see REPORTING REQUIREMENTS, below, for more information.

XI. REPORTING REQUIREMENTS

An annual report detailing the monitoring and survey data collected during the preceding year (required in the above Terms and Conditions) and summarizing all piping plover, red knot, shorebird, seabeach amaranth, and sea turtle data must be provided to the Raleigh Field Office by January 31 of each year for review and comment. In addition, any information or data related to a conservation measure or recommendation that is implemented should be included in the annual report. The contact for these reporting requirements is:

Pete Benjamin, Supervisor
Raleigh Field Office
U.S. Fish and Wildlife Service
Post Office Box 33726
Raleigh, North Carolina 27636-3726
(919) 856-4520

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification must be made to the Service Law Enforcement Office below. Additional notification must be made to the Service's Ecological Services Field Office identified above and to the NCWRC at (252) 241-7367. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

Tom Chisdock
U.S. Fish and Wildlife Service
160 Zillicoa St.
Asheville, NC 28801
828-258-2084

XII. COORDINATION OF INCIDENTAL TAKE STATEMENT WITH OTHER LAWS, REGULATIONS, AND POLICIES

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 USC S 703-712), if such take is in compliance with the terms and conditions specified herein. Take resulting from activities that are not in conformance with the Corps permit or this biological opinion (e.g. deliberate harassment of wildlife, etc.) are not considered part of the proposed action and are not covered by this incidental take statement and may be subject to enforcement action against the individual responsible for the act.

XIII. CONSERVATION RECOMMENDATIONS

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

For the benefit of Loggerhead, Green, Leatherback, and Kemp's ridley sea turtles, the Service recommends the following conservation recommendations:

1. Construction activities for this project and similar future projects should be planned to take place outside the main part of the sea turtle nesting and hatching season, as much as possible.

2. Appropriate native salt-resistant dune vegetation should be established on the restored dunes.

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

For the benefit of the piping plover and red knot, the Service recommends the following conservation recommendations:

1. The Corps' and/or Applicant should maintain suitable piping plover and red knot migrating and wintering habitat. Natural accretion at inlets should be allowed to remain. Accreting sand spits on barrier islands provide excellent foraging habitat for migrating and wintering plovers and red knots.

2. A conservation/education display sign would be helpful in educating local beach users about the coastal beach ecosystem and associated rare species. The sign could highlight the life histories and basic biology of piping plovers and red knots, and ways recreationists can assist in species protection efforts (e.g., keeping pets on a leash, removing trash to sealed refuse containers, etc.). The Service would be willing to assist the Applicant in the development of such a sign, in cooperation with NCWRC, interested non-governmental stakeholders (i.e., National Audubon Society), the Corps, and the other interested stakeholders (i.e., property owners, etc.).

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

XIV. REINITIATION NOTICE – CLOSING STATEMENT

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

In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

For this biological opinion, the incidental take will be exceeded when the groin construction and nourishment of 24,500 lf of beach extends beyond the project's authorized boundaries. Incidental take of an undetermined number of young or eggs of sea turtles, piping plovers, red knots, and seabeach amaranth plants has been exempted from the prohibitions of section 9 by this opinion.

LITERATURE CITED

Ackerman, R.A. 1980. Physiological and ecological aspects of gas exchange by sea turtle eggs. American Zoologist 20:575-583.

Amirault, D.L., F. Shaffer, K. Baker, A. Boyne, A. Calvert, J. McKnight, and P. Thomas. 2005. Preliminary results of a five year banding study in Eastern Canada – support for expanding conservation efforts to non-breeding sites? Unpublished Canadian Wildlife Service report.

Amorocho, D. 2003. Monitoring nesting loggerhead turtles (*Caretta caretta*) in the central Caribbean coast of Colombia. Marine Turtle Newsletter 101:8-13.

Anders, F.J., and S.P. Leatherman. 1987. Disturbance of beach sediment by off-road vehicles. Environmental Geology and Water Sciences 9:183-189.

Anonymous. 1992. First Kemp's ridley nesting in South Carolina. Marine Turtle Newsletter 59:23.

Antas, P.T.Z., and I.L.S. Nascimento. 1996. Analysis of red knot *Calidris canutus rufa* banding data in Brazil. International Wader Studies 8:63-70.

Arvin, J.C. 2009. Hurricane shifts plover populations. Gulf Coast Bird Observatory's Gulf Crossings. Vol. 13, No.1.

Ashton, A.D., J.P. Donnelly, and R.L. Evans. 2007. A discussion of the potential impacts of climate change on the shorelines of the northeastern USA. Unpublished report prepared for the Northeast Climate Impacts Assessment, Union of Concerned Scientists, Woods Hole Oceanographic Institution, Woods Hole, MA, Available at <http://www.georgetownclimate.org/resources/a-discussion-of-the-potential-impacts-of-climate-change-on-the-shorelines-of-the-northeast>.

Atlantic States Marine Fisheries Commission. 1998. Interstate fishery management plan for horseshoe crab. Fishery management report no. 32, Available at <http://http://www.asmfc.org>.

Baker, A.J., P.M. González, T. Piersma, L.J. Niles, d.N. de Lima Serrano, P.W. Atkinson, N.A. Clark, C.D.T. Minton, M.K. Peck, G. Aarts, and et al. 2004. Rapid population decline in red knots: Fitness consequences of decreased refuelling rates and late arrival in Delaware Bay. Proceedings of the Royal Society Biological Sciences Series B 271(1541):875-882.

Baker, S. and B. Higgins. 2003. Summary of CWT project and recoveries, tag detection, and protocol for packaging and shipping Kemp's ridley flippers. Unpublished presentation at the Sea Turtle Stranding and Salvage Network annual meeting. February 2003.

Baldwin, R., G.R. Hughes, and R.I.T. Prince. 2003. Loggerhead turtles in the Indian Ocean. Pages 218-232 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Bandedbirds.org. 2012. Bandings and resightings, Available at <http://www.bandedbirds.org>.

Barber, H. and Sons. 2012. Beach cleaning equipment and beach cleaning machines. *http://www.hbarber.com/Cleaners/Beach_Cleaning_Equipment.html*. Accessed August 30, 2012.

Beggs, J.A., J.A. Horrocks, and B.H. Krueger. 2007. Increase in hawksbill sea turtle Eretmochelys imbricata nesting in Barbados, West Indies. Endangered Species Research 3:159-168.

Bent, A.C. 1927. Life histories of North American shore birds: Order Limicolae (Part 1). Smithsonian Institution United States National Museum Bulletin (142):131-145.

Bent, A.C. 1929. Life histories of North American Shorebirds. U.S. Natural Museum Bulletin 146:236-246.

Bernardo, J. and P.T. Plotkin. 2007. An evolutionary perspective on the arribada phenomenon and reproductive behavior polymorphism of olive ridley sea turtles (*Lepidochelys olivacea*). Pages 59-87 *in* Plotkin, P.T. (editor). Biology and Conservation of Ridley Sea Turtles. John Hopkins University Press, Baltimore, Maryland.

Bibby, R., S. Widdicombe, H. Parry, J. Spicer, and R. Pipe. 2008. Effects of ocean acidification on the immune response of the blue mussel *Mytilus edulis*. Aquatic Biology 2:67-74.

Billes, A., J.-B. Moundemba, and S. Gontier. 2000. Campagne Nyamu 1999-2000. Rapport de fin de saison. PROTOMAC-ECOFAC. 111 pages.

Bimbi, M. 2012. Biologist. E-mails of September 12, and November 1, 2012. U.S. Fish and Wildlife Service, Recovery and Endangered Species, South Carolina Field Office. Charleston, SC.

Bimbi, M. 2013. Biologist. E-mails of January 31, June 27, and July 2, 2013. U.S. Fish and Wildlife Service, Recovery and Endangered Species, South Carolina Field Office, Charleston, SC.

Bjorndal, K.A., A.B. Meylan, and B.J. Turner. 1983. Sea turtles nesting at Melbourne Beach, Florida, I. Size, growth and reproductive biology. Biological Conservation 26:65-77.

Blair, K. 2005. Determination of sex ratios and their relationship to nest temperature of loggerhead sea turtle (*Caretta caretta*, L.) hatchlings produced along the southeastern Atlantic coast of the United States. Unpublished Master of Science thesis. Florida Atlantic University, Boca Raton, Florida.

Bleakney, J.S. 1955. Four records of the Atlantic ridley turtle, *Lepidochelys kempi*, from Nova Scotia. Copeia 2:137.

Blomqvist, S., N. Holmgren, S. Åkesson, A. Hedenström, and J. Pettersson. 2002. Indirect effects of lemming cycles on sandpiper dynamics: 50 years of counts from southern Sweden. Oecologia 133(2):146-158.

Bolten, A.B. 2003. Active swimmers - passive drifters: the oceanic juvenile stage of loggerheads in the Atlantic system. Pages 63-78 in Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Bolten, A.B. and H.R. Martins. 1990. Kemp's ridley captured in the Azores. Marine Turtle Newsletter 48:23.

Botton, M.L., R.E. Loveland, and T.R. Jacobsen. 1988. Beach erosion and geochemical factors: Influence on spawning success of horseshoe crabs (*Limulus polyphemus*) in Delaware Bay. Marine Biology 99(3):325-332.

Botton, M.L., R.E. Loveland, and T.R. Jacobsen. 1994. Site selection by migratory shorebirds in Delaware Bay, and its relationship to beach characteristics and abundance of horseshoe crab (*Limulus polyphemus*) eggs. The Auk 111(3):605-616.

Boulon, R.H., Jr. 1983. Some notes on the population biology of green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles in the northern U.S Virgin Islands; 1981-83. Report to the National Marine Fisheries Service, Grant No. NA82-GA-A-ooo44. 18 pages.

Boulon, R.H., Jr. 1984. Growth rates of wild juvenile hawksbill turtles, *Eretmochelys imbricata*, in St. Thomas, United States Virgin Islands. Copeia 1994(3):811-814.

Bowen, B. W., A.L. Bass, L. Soares, and R.J. Toonen. 2005. Conservation implications of complex population structure: lessons from the loggerhead turtle (*Caretta caretta*). Molecular Ecology 14:2389-2402.

Breese, G. 2010. Compiled by Gregory Breese from notes and reports. Unpublished report to U.S. Fish and Wildlife Service, Shorebird Technical Committee.

Breese, G. 2013. Project Leader. E-mails of March 11, 12, 25, and April 26 and 29, 2013. US Fish & Wildlife Service, Delaware Bay Estuary Project. Smyrna, Delaware.

Brongersma, L.D. 1972. European Atlantic Turtles. Zoologische Verhandelingen 121:318.

Brongersma, L. and A. Carr. 1983. *Lepidochelys kempii* (Garman) from Malta. Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen (Series C) 86(4):445-454.

Bucher, M. A., and A. S. Weakley. 1990. Status survey of seabeach amaranth (Amaranthus pumilus Rafinesque) in North and South Carolina. Report to the North Carolina Plant Conservation Program, Raleigh, NC and the U.S. Fish and Wildlife Service, Asheville, NC.

Burchfield, P.M. and J.L Peña. 2011. Final report on the Mexico/United Stated of America population for the Kemp's Ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaupilas, Mexico. 2011. Annual report to Fish and Wildlife Service. 43 pages.

Burger, J. 1986. The effect of human activities on shorebirds in two coastal bays in the Northeastern United States. Environmental Conservation 13:123-130.

Burger, J. 1991. Foraging behavior and the effect of human disturbance on the piping plover (*Charadrius melodus*). Journal of Coastal Research 7:39-52.

Burger, J. 1994. The effect of human disturbance on foraging behavior and habitat use in piping plover (*Charadrius melodus*). Estuaries 17:695-701.

Burger, J., L.J. Niles, R.R. Porter, A.D. Dey, S. Koch, and C. Gordon. 2012. Migration and over-wintering of red knots (*Calidris canutus rufa*) along the Atlantic coast of the United States. The Condor 114(2):1-12.

Burton, N.H.K., P.R. Evans, and M.A. Robinson. 1996. Effects on shorebirds numbers of disturbance, the loss of a roost site and its replacement by an artificial island at Hartlepool, Cleveland. Biological Conservation 77:193-201.

Caldwell, D.K. 1962. Comments on the nesting behavior of Atlantic loggerhead sea turtles, based primarily on tagging returns. Quarterly Journal of the Florida Academy of Sciences 25(4):287-302.

Camfield, F.E. and C.M. Holmes. 1995. Monitoring completed coastal projects. Journal of Performance of Constructed Facilities 9:169-171.

Carr, A. 1961. The ridley mystery today. Animal Kingdom 64(1):7-12.

Carr, A. 1963. Panspecific reproductive convergence in *Lepidochelys kempii*. Ergebnisse der Biologie 26:298-303.

Carr, A. and L. Ogren. 1960. The ecology and migrations of sea turtles, 4. The green turtle in the Caribbean Sea. Bulletin of the American Museum of Natural History 121(1):1-48.

Chaloupka, M. 2001. Historical trends, seasonality and spatial synchrony in green sea turtle egg production. Biological Conservation 101:263-279.

Christens, E. 1990. Nest emergence lag in loggerhead sea turtles. Journal of Herpetology 24(4):400-402.

Clark, K.E., L.J. Niles, and J. Burger. 1993. Abundance and distribution of migrant shorebirds in Delaware Bay. The Condor 95:694-705.

Clark, K.E., R.R. Porter, and J.D. Dowdell. 2009. The shorebird migration in Delaware Bay. New Jersey Birds 35(4):85-92.

Coastal Engineering Research Center. 1984. Shore protection manual, volumes I and II. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Cohen, J. B., J. D. Fraser, and D. H. Catlin. 2006. Survival and site fidelity of piping plovers on Long Island, New York. Journal of Field Ornithology 77:409-417.

Cohen, J.B., S.M. Karpanty, D.H. Catlin, J.D. Fraser, and R.A. Fischer. 2008. Winter ecology of piping plovers at Oregon Inlet, North Carolina. Waterbirds 31:472-479.

Cohen, J. 2009. Electronic mail dated 15 and 16 January 2009 from Jonathan Cohen, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, to Anne Hecht, USFWS.

Cohen, J.B., S.M. Karpanty, J.D. Fraser, B.D. Watts, and B.R. Truitt. 2009. Residence probability and population size of red knots during spring stopover in the mid-Atlantic region of the United States. Journal of Wildlife Management 73(6):939-945.

Cohen, J.B., S.M. Karpanty, J.D. Fraser, and B.R. Truitt. 2010. The effect of benthic prey abundance and size on red knot (*Calidris canutus*) distribution at an alternative migratory stopover site on the US Atlantic Coast. Journal of Ornithology 151:355-364.

Collard, S.B. and L.H. Ogren. 1990. Dispersal scenarios for pelagic post-hatchling sea turtles. Bulletin of Marine Science 47(1):233-243.

Committee on the Status of Endangered Wildlife in Canada. 2007. COSEWIC assessment and status report on the red knot Calidris canutus in Canada. COSEWIC, Gatineau, QC, Available at < http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_calidris_canutus_e.pdf>.

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Uptite, and B.E. Witherington. 2009. Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act. Report to the National Marine Fisheries Service, Silver Spring, Maryland, USA. 219 pages.

Congdon, J.D., A.E. Dunham, and R.C. van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. Conservation Biology 7(4):826-833.

Corliss, L.A., J.I. Richardson, C. Ryder, and R. Bell. 1989. The hawksbills of Jumby Bay, Antigua, West Indies. Pages 33-35 *in* Eckert, S.A., K.L. Eckert, and T.H. Richardson (compilers). Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232.

Council Conservation of Arctic Flora and Fauna [CAFF]. 2010. Arctic Biodiversity Trends 2010 – Selected indicators of change. CAFF, Akureyri, Iceland, Available at <http://www.caff.is/publications/view_document/162-arctic-biodiversity-trends-2010-selected-indicators-of-change>.

Coutu, S.D., J.D. Fraser, J.L. McConnaughy, and J.P. Loegering. 1990. Piping plover distribution and reproductive success on Cape Hatteras National Seashore. Unpublished report to the National Park Service.

Crain, D.A., A.B. Bolten, and K.A. Bjorndal. 1995. Effects of beach nourishment on sea turtles: review and research initiatives. Restoration Ecology 3(2):95-104.

Cross, R.R. 1990. Monitoring, management and research of the piping plover at Chincoteague National Wildlife Refuge. Unpublished report. Virginia Department of Game and Inland Fisheries, Richmond, Virginia.

Crouse, D. 1999. Population modeling and implications for Caribbean hawksbill sea turtle management. Chelonian Conservation and Biology 3(2):185-188.

Cummings, V., J. Hewitt, A. Van Rooyen, K. Currie, S. Beard, S. Thrush, J. Norkko, N. Barr, P. Heath, N.J. Halliday, and et al. 2011. Ocean acidification at high latitudes: Potential effects on functioning of the Antarctic bivalve *Laternula elliptica*. PLoS ONE 6(1):e16069.

Cuthbert, F.J. and E.A. Roche. 2006. Piping plover breeding biology and management in the Great Lakes, 2006. Report submitted to the US Fish and Wildlife Service, East Lansing, MI.

Cuthbert, F.J. and E.A. Roche. 2007. Estimation and evaluation of demographic parameters for recovery of the endangered Great Lakes piping plover population. Unpublished report submitted to the US Fish and Wildlife Service, East Lansing, MI.

Dahlen, M.K., R. Bell, J.I. Richardson, and T.H. Richardson. 2000. Beyond D-0004: Thirty-four years of loggerhead (*Caretta caretta*) research on Little Cumberland Island, Georgia, 1964-1997. Pages 60-62 *in* Abreu-Grobois, F.A., R. Briseno-Duenas, R. Marquez, and L. Sarti (compilers). Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-436.

Daniel, R.S. and K.U. Smith. 1947. The sea-approach behavior of the neonate loggerhead turtle (*Caretta caretta*). Journal of Comparative and Physiological Psychology 40(6):413-420.

Davis, G.E. and M.C. Whiting. 1977. Loggerhead sea turtle nesting in Everglades National Park, Florida, U.S.A. Herpetologica 33:18-28.

Dean, C. 1999. Against the tide: the battle for America's beaches. Columbia University Press; New York, New York.

Defeo, O., A. McLachlan, D.S. Schoeman, T.A. Schlacher, J. Dugan, A. Jones, M. Lastra, and F. Scapini. 2009. Threats to sandy beach ecosystems: a review. Estuarine, Coastal and Shelf Science 81:1–12.

Deraniyagala, P.E.P. 1938. The Mexican loggerhead turtle in Europe. Nature 142:540.

Dey, A., L. Niles, H. Sitters, K. Kalasz, and R.I.G. Morrison. 2011. Update to the status of the red knot *Calidris canutus* in the Western Hemisphere, April, 2011, with revisions to July 14, 2011. Unpublished report to New Jersey Department of Environmental Protection, Division of Fish and Wildlife, Endangered and Nongame Species Program.

Dey, A. 2012. Principal Zoologist. E-mails of August 9, 13, 20; October 12, 29; November 19; and December 3, 2012. New Jersey Department of Environmental Protection, Division of Fish and Wildlife, Endangered & Nongame Species Program. Millville, NJ.

Dickerson, D.D. and D.A. Nelson. 1989. Recent results on hatchling orientation responses to light wavelengths and intensities. Pages 41-43 *in* Eckert, S.A., K.L. Eckert, and T.H. Richardson (compilers). Proceedings of the 9th Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232.

Diez, C. E. 2011. Personal communication to the U.S. Fish and Wildlife Service. Puerto Rico Department of Natural and Environmental Resources.

Diez, C.E., R.P. van Dam. 2002. Habitat effect on hawksbill turtle growth rates on feeding grounds at Mona and Monito Islands, Puerto Rico. Marine Ecology Progress Series 234:301-309.

Dinsmore, S.J., J.A. Collazo, and J.R. Walters. 1998. Seasonal numbers and distribution of shorebirds on North Carolina's Outer Banks Wilson Bulletin 110:171-181.

Dodd, C.K., Jr. 1988. Synopsis of the biological data the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report 88(14).

Dodd, M.G. and A.H. Mackinnon. 1999. Loggerhead turtle (*Caretta caretta*) nesting in Georgia, 1999: implications for management. Georgia Department of Natural Resources report

Dodd, M.G. and A.H. Mackinnon. 2000. Loggerhead turtle (*Caretta caretta*) nesting in Georgia, 2000: implications for management. Georgia Department of Natural Resources unpublished report.

Dodd, M.G. and A.H. Mackinnon. 2001. Loggerhead turtle (*Caretta caretta*) nesting in Georgia, 2001. Georgia Department of Natural Resources. Report to the U.S. Fish and Wildlife Service, Jacksonville, Florida..

Dodd, M.G. and A.H. Mackinnon. 2002. Loggerhead turtle (*Caretta caretta*) nesting in Georgia, 2002. Georgia Department of Natural Resources. Report submitted to the U.S. Fish and Wildlife Service, Jacksonville, Florida.

Dodd, M.G. and A.H. Mackinnon. 2003. Loggerhead turtle (*Caretta caretta*) nesting in Georgia, 2003. Georgia Department of Natural Resources. Report submitted to the U.S. Fish and Wildlife Service, Jacksonville, Florida.

Dodd, M.G. and A.H. Mackinnon. 2004. Loggerhead turtle (*Caretta caretta*) nesting in Georgia, 2004. Georgia Department of Natural Resources. Report submitted to the U.S. Fish and Wildlife Service, Jacksonville, Florida.

Dodge, K.D., R. Prescott, D. Lewis, D. Murley, and C. Merigo. 2003. A review of cold stun strandings on Cape Cod, Massachusetts from 1979-2003. Unpublished Poster NOAA, Mass Audubon, New England Aquarium. http://galveston.ssp.nmfs.gov/research/protectedspecies/

Drake, K.R. 1999a. Movements, habitat use and survival of wintering piping plovers. M.S. Thesis. Texas A&M University-Kingsville, Kingsville, TX. 82 pp.

Drake, K. R. 1999b. Time allocation and roosting habitat in sympatrically wintering piping and snowy plovers. M. S. Thesis. Texas A&M University-Kingsville, Kingsville, TX. 59 pp.

Drake, K.R., J.E. Thompson, K.L. Drake, and C. Zonick. 2001. Movements, habitat use, and survival of non-breeding Piping Plovers. Condor 103(2):259-267.

Duerr, A.E., B.D. Watts, and F.M. Smith. 2011. Population dynamics of red knots stopping over in Virginia during spring migration. Center for Conservation Biology technical report series. College of William and Mary & Virginia Commonwealth University, CCBTR-11-04, Williamsburg, VA.

Dugan, J.E., D.M. Hubbard, M.D. McCrary, and M.O. Pierson. 2003. The response of macrofauna communities and shorebirds to macrophyte wrack subsidies on exposed sandy beaches of southern California. Estuarine. Coastal and Shelf Science 58, 25-40.

Dugan and Hubbard. 2006. Ecological responses to coastal armoring on exposed sandy beaches. Journal of the American Shore and Beach Preservation Association. Winter. Volume 74, No. 1.

Dunne, P., D. Sibley, C. Sutton, and W. Wander. 1982. 1982 aerial shorebird survey of the Delaware Bay endangered species. New Jersey Birds 9:68-74.

Dutton, D.L., P.H. Dutton, M. Chaloupka, and R.H. Boulon. 2005. Increase of a Caribbean leatherback turtle *Dermochelys coriacea* nesting population linked to long-term nest protection. Biological Conservation 126:186-194.

eBird.org. 2014. eBird: An online database of bird distribution and abundance [web application]. Cornell Lab of Ornithology, Ithaca, New York. , Available at http://www.ebird.org/.

eBird.org. 2012. eBird: An online database of bird distribution and abundance [web application]. Cornell Lab of Ornithology, Ithaca, New York. , Available at http://www.ebird.org/.

Ehrhart, L.M. 1989. Status report of the loggerhead turtle. Pages 122-139 *in* Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart, and R. Witham (editors). Proceedings of the 2nd Western Atlantic Turtle Symposium. NOAA Technical Memorandum NMFS-SEFC-226.

Ehrhart, L.M., D.A. Bagley, and W.E. Redfoot. 2003. Loggerhead turtles in the Atlantic Ocean: geographic distribution, abundance, and population status. Pages 157-174 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Elliott, L.F. and T. Teas. 1996. Effects of human disturbance on threatened wintering shorebirds. In fulfillment of Texas Grant number E-1-8. Project 53. 10 pp.

Elliott-Smith, E., Haig, S.M., and Powers, B.M.. 2009. Data from the 2006 International Piping Plover Census: U.S. Geological Survey Data Series 426, 332 p.

Emanuel, K. 2005. Increasing destructiveness of tropical cyclones over the past 30 years. Nature, Volume 436(4), pp. 686-688.

Encalada, S.E., J.C. Zurita, and B.W. Bowen. 1999. Genetic consequences of coastal development: the sea turtle rookeries at X'cacel, Mexico. Marine Turtle Newsletter 83:8-10.

Environment Canada. 2006. Recovery Strategy for the Piping Plover (*Charadrius melodus circumcinctus*) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa.

Environmental Protection Agency. 2009. Coastal Zones and sea level rise. Accessed on 29 January 2009 at http://www.epa.gov/climatechange/effects/coastal/ index/html.

Ernest, R.G. and R.E. Martin. 1993. Sea turtle protection program performed in support of velocity cap repairs, Florida Power & Light Company St. Lucie Plant. Applied Biology, Inc., Jensen Beach, Florida.

Ernest, R.G. and R.E. Martin. 1999. Martin County beach nourishment project: sea turtle monitoring and studies. 1997 annual report and final assessment. Unpublished report prepared for the Florida Department of Environmental Protection.

Escudero, G., J.G. Navedo, T. Piersma, P. De Goeij, and P. Edelaar. 2012. Foraging conditions 'at the end of the world' in the context of long-distance migration and population declines in red knots. Austral Ecology 37:355-364.

Espoz, C., A. Ponce, R. Matus, O. Blank, N. Rozbaczylo, H.P. Sitters, S. Rodriguez, A.D. Dey, and L.J. Niles. 2008. Trophic ecology of the red knot *Calidris canutus rufa* at Bahía Lomas, Tierra del Fuego, Chile. Wader Study Group Bulletin 115(2):69-76.

Fabry, V.J., B.A. Seibel, R.A. Feely, and J.C. Orr. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. ICES Journal of Marine Science 65:414-432.

Farley, R. 2009. Phone conversation on 11 February 2009 between Robert Farley, Planning and Landscape Architecture, Post, Buckley, Schuh, and Jernigan, Inc. and Patricia Kelly, USFWS, Panama City, Florida, Field Office regarding status of beach vitex on northwest Florida beaches.

Farrell, J.G., and C.S. Martin. 1997. Proceedings of the Horseshoe Crab Forum: Status of the resource. University of Delaware, Sea Grant College Program, Newark, Delaware.

Feng, S., C. Ho, Q. Hu, R.J. Oglesby, and S. Jeong. 2012. Evaluating observed and projected future climate changes for the Arctic using the Koppen-Trewartha climate classification. Climate Dynamics 38:1359-1373.

Fenster, M., and R. Dolan. 1996. Assessing the impact of tidal inlets on adjacent barrier island shorelines. Journal of Coastal Research 12(1):294-310.

Fletemeyer, J. 1980. Sea turtle monitoring project. Unpublished report prepared for the Broward County Environmental Quality Control Board, Florida.

Florida Department of Environmental Protection. 2009. Critically eroded beaches in Florida. Bureau of Beaches and Coastal Systems. Tallahassee, Florida http://www.dep.state.fl.us/BEACHES/publications/pdf/CritEroRpt09.pdf

Florida Fish and Wildlife Conservation Commission. 2007. Light sources contributing to reported disorientation events in Florida, 2007. http://www.myfwc.com/docs/WildlifeHabitats/Seaturtle_DisorientationEvents2007.pdf

Florida Fish and Wildlife Conservation Commission. 2008a. Reported nesting activity of the Kemps Ridley (*Lepidochelys kempii*), in Florida, 1979-2007. Fish and Wildlife Research Institute. http://research.myfwc.com/images/articles/2377/sea_turtle_nesting_on_florida_bchs_93-07.pdf

Florida Fish and Wildlife Conservation Commission. 2008b. Personal communication to the Loggerhead Recovery Team. Florida Fish and Wildlife Research Institute.

Florida Fish and Wildlife Conservation Commission. 2009a. Statewide Nesting Beach Survey database http://research.myfwc.com/features/view_article.asp?id=10690

Florida Fish and Wildlife Conservation Commission. 2009b. Index Nesting Beach Survey Totals. http://research.myfwc.com/features/view_article.asp?id=10690

Florida Fish and Wildlife Conservation Commission. 2009c. Florida's endangered species, threatened species, and species of special concern. http://research.myfwc.com/features/view_article.asp?id=5182

Florida Fish and Wildlife Conservation Commission/Florida Fish and Wildlife Research Institute. 2010a. A good nesting season for loggerheads in 2010 does not reverse a recent declining trend. http://research.myfwc.com/features/view_article.asp?id=27537

Florida Fish and Wildlife Conservation Commission/Florida Fish and Wildlife Research Institute. 2010b. Index nesting beach survey totals (1989 - 2010). http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals-1989-2010/

Florida Fish and Wildlife Conservation Commission/Florida Fish and Wildlife Research Institute. 2011. Personal communication to the U.S. Fish and Wildlife Service.

Florida Oceans and Coastal Council. 2010. Climate change and sea-level rise in Florida: An update of "The effects of climate change on Florida's ocean and coastal resources". FOCC, Tallahassee, FL, Available at http://www.floridaoceanscouncil.org/reports/Climate_Change_and_Sea_Level_Rise.pdf

Foley, A. 2005. Personal communication to Loggerhead Recovery Team. Florida Fish and Wildlife Research Institute.

Foley, A., B. Schroeder, and S. MacPherson. 2008. Post-nesting migrations and resident areas of Florida loggerheads. Pages 75-76 *in* Kalb, H., A. Rohde, K. Gayheart, and K. Shanker (compilers). Proceedings of the Twenty-fifth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-582.

Fontaine, C.T., S.A. Manzella, T.D. Williams, R.M. Harris, and W.J. Browning. 1989. Distribution, growth and survival of head started, tagged and released Kemp's ridley sea turtle *(Lepidochelys kempii)* from year-classes 1978-1983. Pages 124-144 *in* Caillouet, C.W., Jr., and A.M. Landry Jr. (editors). Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. TAMU-SG:89-105.

Foote, J.J. and T.L. Mueller. 2002. Two Kemp's ridley (*Lepidochelys kempii*) nests on the Gulf coast of Sarasota County, Florida, USA. Page 217 *in* Mosier, A., A. Foley, and B. Brost (compilers). Proceedings of the Twentieth Annual Symposium Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Foote, J., J. Sprinkel, T. Mueller, and J. McCarthy. 2000. An overview of twelve years of tagging data from *Caretta caretta* and *Chelonia mydas* nesting habitat along the central Gulf coast of Florida, USA. Pages 280-283 *in* Kalb, H.J. and T. Wibbels (compilers). Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-443.

Frair, W., R.G. Ackerman, and N. Mrosovsky. 1972. Body temperature of *Dermochelys coriacea:* warm water turtle from cold water. Science 177:791-793.

Francisco-Pearce, A.M. 2001. Contrasting population structure of *Caretta caretta* using mitochondrial and nuclear DNA primers. Unpublished Master of Science thesis. University of Florida, Gainesville, Florida.

Fraser, J.D., S.M. Karpanty, J.B. Cohen, and B.R. Truitt. 2013. The red knot (*Calidris canutus rufa*) decline in the western hemisphere: Is there a lemming connection? Canadian Journal of Zoology 91:13-16.

Frazer, N.B. and J.I. Richardson. 1985. Annual variation in clutch size and frequency for loggerhead turtles, *Caretta-caretta*, nesting at Little Cumberland Island, Georgia, USA. Herpetologica 41(3):246-251.

Fretey, J., A. Billes, and M. Tiwari. 2007. Leatherback *Dermochelys coriacea*, nesting along the Atlantic coast of Africa. Chelonian Conservation and Biology 6(1): 126-129.

Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. Confronting climate change in the U.S. Northeast: Science, impacts, and solutions. Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Union of Concerned Scientists (UCS), Cambridge, MA.

Fussell, John. O. III. 1994. A Birder's Guide to Coastal North Carolina. University of North Carolina Press. 540 pages.

Galbraith, H., R. Jones, R. Park, J. Clough, S. Herrod-Julius, B. Harrington, and G. Page. 2002. Global climate changes and sea level rise: Potential loss of intertidal habitat for shorebirds. Waterbirds 25:173-183.

Garduño-Andrade, M. 1999. Nesting of the hawksbill turtle, *Eretmochelys imbricata*, in Río Lagartos, Yucatán, Mexico, 1990-1997. Chelonian Conservation and Biology 3(2):281-285.

Garner, J.A. and S.A. Garner. 2010. Saturation tagging and nest management of leatherback sea turtles on (*Dermochelys coriacea*) on Sandy Point, St. Croix, U.S. Virgin Island, 2010. Annual report to U.S. Fish and Wildlife Service. 49 pages.

Gaylord, B., T.M. Hill, E. Sanford, E.A. Lenz, L.A. Jacobs, K.N. Sato, A.D. Russell, and A. Hettinger. 2011. Functional impacts of ocean acidification in an ecologically critical foundation species. Journal of Experimental Biology 214:2586-2594.

Georges, A, C. Limpus, J. Parmenter. 1993. Natural History of Chelonia. Fauna of Australia, 2A: 1-18.

Gerasimov, K.B. 2009. Functional morphology of the feeding apparatus of red knot *Calidris canutus*, great knot *C. tenuirostris* and surfbird *Aphriza virgate*. *In* International Wader Study Group Annual Conference, September 18-21, 2009, International Wader Study Group, Norfolk, UK.

Gerrodette, T. and J. Brandon. 2000. Designing a monitoring program to detect trends. Pages 36-39 *in* Bjorndal, K.A. and A.B. Bolten (editors). Proceedings of a Workshop on Assessing Abundance and Trends for In-water Sea Turtle Populations. NOAA Technical Memorandum NMFS-SEFSC-445.

Gibbs, J.P. 1986. Feeding ecology of nesting piping plovers in Maine. Unpublished report to Maine Chapter, The Nature Conservancy, Topsham, Maine.

Gibson, M., C.W. Nathan, A.K. Killingsworth, C.Shankles, E. Coleman, S. Bridge, H. Juedes, W. Bone, and R. Shiplett. 2009. Observations and implications of the 2007 amalgamation of Sand-Pelican Island to Dauphin Island, Alabama. Geological Society of America. Paper No. 20-10, Southeastern Section - 58th Annual Meeting. Volume 41, No.1, p. 52.

Glenn, L. 1998. The consequences of human manipulation of the coastal environment on hatchling loggerhead sea turtles (*Caretta caretta*, L.). Pages 58-59 *in* Byles, R., and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Glen, F. and N. Mrosovsky. 2004. Antigua revisited: the impact of climate change on sand and nest temperatures at a hawksbill turtle (*Eretmochelys imbricata*) nesting beach. Global Change Biology 10:2036-2045.

Godfrey, M.H. and N. Mrosovsky. 1997. Estimating the time between hatching of sea turtles and their emergence from the nest. Chelonian Conservation and Biology 2(4):581-585.

Godfrey, P.J., S.P. Leatherman, and P.A. Buckley. 1978. Impact of off-road vehicles on coastal ecosystems. Pages 581-599 *in* Coastal Zone '78 Symposium on Technical, Environmental Socioeconomic and Regulatory Aspects of Coastal Zone Management. Vol. II, San Francisco, California.

Goldin, M.R., C.Griffin, and S. Melvin. 1990. Reproductive and foraging ecology, human disturbance, and management of piping plovers at Breezy Point, Gateway National Recreational Area, New York, 1989. Progress report for U.S. Fish and Wildlife Service, Newton Corner, Massachusetts.

Goldin, M.R. 1993. Piping Plover (Charadrius melodus) management, reproductive ecology, and chick behavior at Goosewing and Briggs Beaches, Little Compton, Rhode Island, 1993. The Nature Conservancy, Providence, Rhode Island.

González, P.M. 2005. Report for developing a red knot status assessment in the U.S. Unpublished report by Fundacion Inalafquen, Rio Negro, Argentina.

González, P.M., A.J. Baker, and M.E. Echave. 2006. Annual survival of red knots (*Calidris canutus rufa)* using the San Antonio Oeste stopover site is reduced by domino effects involving late arrival and food depletion in Delaware Bay. Hornero 21(2):109-117.

Goss-Custard, J.D., R.T. Clarke, S.E.A. le V. dit Durell, R.W.G. Caldow, and B.J. Ens. 1996. Population consequences of winter habitat loss in migratory shorebird. II. Model predictions. Journal of Applied Ecology 32:337-351.

Gratto-Trevor, C., D. Amirault-Langlais, D. Catlin, F. Cuthbert, J. Fraser, S. Maddock, E. Roche, and F. Shaffer. 2009. Winter distribution of four different piping plover breeding populations. Report to U.S. Fish and Wildlife Service. 11 pp.

Green, M.A., G.G. Waldbusser, S.L. Reilly, K. Emerson, and S. O'Donnell. 2009. Death by dissolution: Sediment saturation state as a mortality factor for juvenile bivalves. Limnology and Oceanography 54(4):1037-1047.

Greene, K. 2002. Beach nourishment: A review of the biological and physical impacts. ASMFC Habitat Management Series # 7. ASMFC, Washington, DC., Available at <http://www.asmfc.org/publications/habitat/beachNourishment.pdf>

Greer, A.E., J.D. Lazell, Jr., and R.M. Wright. 1973. Anatomical evidence for counter-current heat exchanger in the leatherback turtle (*Dermochelys coriacea*). Nature 244:181.

Griffin, C.R. and S.M. Melvin. 1984. Research plan on management, habitat selection, and population dynamics of piping plovers on outer Cape Cod, Massachusetts. University of Massachusetts. Research proposal submitted to U.S. Fish and Wildlife Service, Newton Corner, Massachusetts.

Guilfoyle, M.P., R.A. Fischer, D.N. Pashley, and C.A. Lott editors. 2006. Summary of first regional workshop on dredging, beach nourishment, and birds on the south Atlantic coast. ERDC/EL TR-06-10. U.S. Army Corps of Engineers, Washington, DC, Available at <http://www.fws.gov/raleigh/pdfs/ES/trel06-10.pdf>.

Guilfoyle, M.P., R.A. Fischer, D.N. Pashley, and C.A. Lott editors. 2007. Summary of second regional workshop on dredging, beach nourishment, and birds on the north Atlantic coast. ERDC/EL TR-07-26. U.S. Army Corps of Engineers, Washington, DC, Available at <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA474358>.

Gyuris E., 1994. The rate of predation by fishes on hatchlings of the green turtle. *Coral Reefs* 12:137.

Haig, S.M. 1992. Piping Plover. In The Birds of North America, No. 2 (A. Poole, P. Stettenheim, & F. Gill, eds). Philadelphia: The academy of Natural Sciences; Washington DC: The American Ornithologists' Union. 17 pp.

Haig, S.M., and L.W. Oring. 1985. The distribution and status of the piping plover throughout the annual cycle. Journal of Field Ornithology 56:334-345.

Haig, S.M., and L.W. Oring. 1987. The piping plover. Audubon Wildlife Report. Pp. 509-519.

Haig, S.M., and C.L. Ferland, F.J.Cuthbert, J.Dingledine, J.P. Goossen, A.Hecht, and N.McPhillips. 2005. A complete species census and evidence for regional declines in piping plovers. Journal of Wildlife Management. 69(1): 160-173.

Hailman, J.P. and A.M. Elowson. 1992. Ethogram of the nesting female loggerhead (*Caretta caretta*). Herpetologica 48:1-30.

Hake, M. 1993. 1993 summary of piping plover management program at Gateway NRA Breezy Point district. Unpublished report. Gateway National Recreational Area, Long Island, New York.

Hanlon, H. 2012. Biologist. E-mail of November 22, 2012. U.S. Fish and Wildlife Service, Cape May National Wildlife Refuge. Cape May Court House, NJ.

Hanson, J., T. Wibbels, and R.E. Martin. 1998. Predicted female bias in sex ratios of hatchling loggerhead sea turtles from a Florida nesting beach. Canadian Journal of Zoology 76(10):1850-1861.

Harrington, B.R. 2008. Coastal inlets as strategic habitat for shorebirds in the southeastern United States. DOER Technical Notes Collection. ERDC TN-DOER-E25. Vicksburg, MS: U.S. Army Engineer Research and Development Center. http://el.erdc.usace.army.mil/dots/doer.

Harrington, B.A. 1996. The flight of the red knot: A natural history account of a small bird's annual migration from the Arctic Circle to the tip of South America and back. W. W. Norton & Company, New York.

Harrington, B.A. 2001. Red knot (*Calidris canutus*). *In* A. Poole, and F. Gill, eds. The birds of North America, No. 563, The Birds of North America, Inc., Philadelphia, PA.

Harrington, B.A. 2005a. Unpublished information on red knot numbers and distribution in the eastern United States: Based largely on ongoing projects and manuscripts under development at the Manomet Center for Conservation Sciences and the Georgia Department of Natural Resources.

Harrington, B.A. 2005b. Studies of disturbance to migratory shorebirds with a focus on Delaware Bay during north migration. Unpublished report by Manomet Center for Conservation Sciences, Manomet, MA.

Harrington, B.A., J.M. Hagen, and L.E. Leddy. 1988. Site fidelity and survival differences between two groups of New World red knots (*Calidris canutus*). The Auk 105:439-445.

Harrington, B. 2012. Biologist. E-mail of November 12, 2012. Manomet Center for Conservation Sciences. Manomet, MA.

Hawkes, L.A., A.C. Broderick, M.H. Godfrey, and B.J. Godley. 2005. Status of nesting loggerhead turtles *Caretta caretta* at Bald Head Island (North Carolina, USA) after 24 years of intensive monitoring and conservation. Oryx 39(1):65-72.

Hawkes, L.A., A.C. Broderick, M.H. Godfrey, and B.J. Godley. 2008. Climate change and marine turtles. Endangered Species Research 7:137-154.

Hayes, M.O. and J. Michel. 2008. A coast for all seasons: A naturalist's guide to the coast of South Carolina. Pandion Books, Columbia, South Carolina. 285 pp.

Hays, G.C. 2000. The implications of variable remigration intervals for the assessment of population size in marine turtles. Journal of Theoretical Biology 206:221-227.

Hecht, A., and S. M. Melvin. 2009. Expenditures and effort associated with recovery of breeding Atlantic Coast piping plovers. Journal of Wildlife Management 73(7):1099-1107.

Hegna, R.H., M.J. Warren, C.J. Carter, and J.C. Stiner. 2006. *Lepidochelys kempii* (Kemp's Ridley sea turtle). Herpetological Review 37(4):492.

Helmers, D.L. 1992. Shorebird management manual. Western Hemisphere Shorebird Reserve. Network, Manomet, Massachusetts, USA.

Hendrickson, J.R. 1958. The green sea turtle *Chelonia mydas* (Linn.) in Malaya and Sarawak. Proceedings of the Zoological Society of London 130:455-535.

Heppell, S.S. 1998. Application of life-history theory and population model analysis to turtle conservation. Copeia 1998(2):367-375.

Heppell, S.S., L.B. Crowder, and T.R. Menzel. 1999. Life table analysis of long-lived marine species with implications for conservation and management. Pages 137-148 *in* Musick, J.A. (editor). Life in the Slow Lane: Ecology and Conservation of Long-lived Marine Animals. American Fisheries Society Symposium 23, Bethesda, Maryland.

Heppell, S.S., L.B. Crowder, D.T. Crouse, S.P. Epperly, and N.B. Frazer. 2003. Population models for Atlantic loggerheads: past, present, and future. Pages 225-273 in Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washinghton D.C.

Heppell, S.S., D.T. Crouse, L.B. Crowder, S.P. Epperly, W. Gabriel, T. Henwood, R. Marquez, and N.B. Thompson. 2005. A population model to estimate recovery time, population size, and management impacts on Kemp's ridley sea turtles. Chelonian Conservation and Biology 4(4):767-773.

Herren, R.M. 1999. The effect of beach nourishment on loggerhead (*Caretta caretta*) nesting and reproductive success at Sebastian Inlet, Florida. Unpublished Master of Science thesis. University of Central Florida, Orlando, Florida. 138 pages.

Hildebrand, H.H. 1963. Hallazgo del área de anidación de la tortuga marina "lora" *Lepidochelys kempi* (Garman), en la coasta occidental del Golfo de México. Sobretiro de Ciencia, México 22:105-112.

Hirth, H.F. 1997. Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report 97(1).

Hoopes, E.M. 1993. Relationships between human recreation and piping plover foraging ecology and chick survival. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts.

Hopkins, S.R. and T.M. Murphy. 1980. Reproductive ecology of *Caretta caretta* in South Carolina. South Carolina Wildlife Marine Resources Department Completion Report.

Hopkinson, C.S., A.E. Lugo, M. Alber, A.P. Covich, and S.J. Van Bloem. 2008. Forecasting effects of sea-level rise and windstorms on coastal and inland ecosystems. Frontiers in Ecology and Environment 6:255-263.

Hosier, P.E., M. Kochhar, and V. Thayer. 1981. Off-road vehicle and pedestrian track effects on the sea –approach of hatchling loggerhead turtles. Environmental Conservation 8:158-161.

Houghton, J.D.R. and G.C. Hays. 2001. Asynchronous emergence by loggerhead turtle (*Caretta caretta*) hatchlings. Naturwissenschaften 88:133-136.

Howard, B. and P. Davis. 1999. Sea turtle nesting activity at Ocean Ridge in Palm Beach County, Florida 1999. Palm Beach County Department of Environmental Resources Management, West Palm Beach, Florida.

Hubbard, D.M. and J.E. Dugan. 2003. Shorebird use of an exposed sandy beach in southern California. Estuarine Coastal Shelf Science 58, 41-54.

Hughes, A.L. and E.A. Caine. 1994. The effects of beach features on hatchling loggerhead sea turtles. Pages 237 *in* Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar (compilers). Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351.

Humiston and Moore Engineers. 2001. "Naples Beach Erosion Control Project 1-Year Post Construction Monitoring Report." Prepared for The City of Naples, Florida.

Ims, R.A., and E. Fuglei. 2005. Trophic interaction cycles in tundra ecosystems and the impact of climate change. BioScience 55(4):311-322.

Insacco, G. and F. Spadola. 2010. First record of Kemp's ridley sea turtle, *Lepidocheyls kempii* (Garman 1880) (Cheloniidae), from the Italian waters (Mediterranean Sea). Acta Herpetologica 5(1):113-117.

Intergovernmental Panel on Climate Change. 2007a. Summary for Policymakers. In Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (editors). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, New York, USA.

Intergovernmental Panel on Climate Change. 2007b. Summary for Policymakers. In Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (editors). Climate Change 2007: Climate Change Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, New York, USA.

International Wader Study Group. 2003. Wader Study Group Workshop 26 September 2003 - Are waders world-wide in decline? Reviewing the evidence. Wader Study Group Bulletin 101/102:8-41.

Invasive Species Specialist Group. 2009. ISSG Global Invasive Species Database: Impact information for *Vitex rotundifolia*. Accessed November 11, 2010: http://www.issg.org/database/species/impact_info.asp?si=1110&fr=1&sts=&lang=EN

Jimenez, M.C., A. Filonov, I. Tereshchenko, and R.M. Marquez. 2005. Time-series analyses of the relationship between nesting frequency of the Kemp's ridley sea turtle and meteorological conditions. Chelonian Conservation and Biology 4(4):774-780.

Johnson, C.M. and G.A. Baldassarre. 1988. Aspects of the wintering ecology of piping plovers in coastal Alabama. Wilson Bulletin 100:214-233.

Johnson, S.A., A.L. Bass, B. Libert, M. Marmust, and D. Fulk. 1999. Kemp's ridley (*Lepidochelys kempi*) nesting in Florida. Florida Scientist 62(3/4):194-204.

Jones, S.J., F.P. Lima, and D.S. Wethey. 2010. Rising environmental temperatures and biogeography: Poleward range contraction of the blue mussel, *Mytilus edulis* L., in the western Atlantic. Journal of Biogeography 37:2243-2259.

Jones, T.T., M.D. Hastings, B.L. Bostrom, D. Pauly, and D.R. Jones. 2011. Growth of captive leatherback turtles, *Dermochelys coriacea*, with inferences on growth in the wild: Implications for population decline and recovery. Journal of Experimental Marine Biology and Ecology 399:84-92.

Kalasz, K. 2008. Delaware shorebird conservation plan. Version 1.0. Delaware Natural Heritage and Endangered Species Program Division of Fish and Wildlife, Delaware Department of Natural Resources & Environmental Control, Smyrna, DE.

Kalasz, K. 2013. Biologist. E-mails of February 8, and March 29, 2013. Delaware Department of Natural Resources and Environmental Control, Delaware Shorebird Project. Dover, DE.

Kamezaki, N., Y. Matsuzawa, O. Abe, H. Asakawa, T. Fujii, K. Goto, S. Hagino, M. Hayami, M. Ishii, T. Iwamoto, T. Kamata, H. Kato, J. Kodama, Y. Kondo, I. Miyawaki, K. Mizobuchi, Y. Nakamura, Y. Nakashima, H. Naruse, K. Omuta, M. Samejima, H. Suganuma, H. Takeshita, T. Tanaka, T. Toji, M. Uematsu, A. Yamamoto, T. Yamato, and I. Wakabayashi. 2003. Loggerhead turtles nesting in Japan. Pages 210-217 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Karpanty, S.M., J.D. Fraser, J.B. Cohen, S. Ritter, B. Truitt, and D. Catlin. 2012. Update of red knot numbers and prey counts in Virginia using ground survey methods. Unpublished report to the Delaware Bay Technical Committee and the Atlantic States Marine Fisheries Commission, Department Fish and Wildlife Conservation.

Kaplan, J.O., N.H. Bigelow, P.J. Bartlein, T.R. Christiansen, W. Cramer, S.M. Harrison, N.V. Matveyeva, A.D. McGuire, D.F. Murray, I.C. Prentice, and et al. 2003. Climate change and Arctic ecosystems II: Modeling, paleodata-model comparisons, and future projections. Journal of Geophysical Research 108(D17):8171.

Kaufman, W. and O. Pilkey. 1979. The Beaches are Moving: The Drowning of America's Shoreline. Anchor Press/Doubleday, Garden City, New York.

Kochenberger, R. 1983. Survey of shorebird concentrations along the Delaware bayshore. Peregrine Observer spring 1983. New Jersey Audubon Publications.

Komar, P.D. 1983. Coastal erosion in response to the construction of jetties and breakwaters. Pages 191-204 *in* Komar, P.D. (editor). CRC Handbook of Coastal Processes and Erosion. CRC Press. Boca Raton, Florida.

Labisky, R.F., M.A. Mercadante, and W.L. Finger. 1986. Factors affecting reproductive success of sea turtles on Cape Canaveral Air Force Station, Florida, 1985. Final report to the United States Air Force. United States Fish and Wildlife Service Cooperative Fish and Wildlife Research Unit, Agreement Number 14-16-0009-1544, Research Work Order Number 25.

Lafferty, K.D. 2001a. Birds at a Southern California beach: Seasonality, habitat use and disturbance by human activity. Biodiversity and Conservation 10:1949-1962.

Lafferty, K.D. 2001b. Disturbance to wintering western snowy plovers. Biological Conservation 101:315-325.

Lamont, M.M., H.F. Percival, L.G. Pearlstine, S.V. Colwell, W.M. Kitchens, and R.R. Carthy. 1997. The Cape San Blas ecological study. U.S. Geological Survey -Biological Resources Division. Florida Cooperative Fish and Wildlife Research Unit Technical Report Number 57.

Lathrop, R.G.,Jr. 2005. Red knot habitat in Delaware Bay: Status and trends. Unpublished report by the Department of Ecology, Evolution & Natural Resources, Center for Remote Sensing & Spatial Analysis, Rutgers University, New Brunswick, NJ.

LeBlanc, D. 2009. Electronic mail dated 29 January 2009 from Darren LeBlanc, USFWS, Daphne, Alabama, Ecological Services Office to Patricia Kelly, USFWS, Panama City, Florida, Field Office regarding habitat changes along Alabama coast from hurricanes.

LeBuff, C.R., Jr. 1990. The loggerhead turtle in the eastern Gulf of Mexico. Caretta Research, Inc.; Sanibel Island, Florida.

LeDee, O.E. 2008. Canaries on the coastline: estimating survival and evaluating the relationship between nonbreeding shorebirds, coastal development, and beach management policy. Ph.D. Dissertation. University of Minnesota, Twin Cities. 73 pp.

Leon, Y.M. and C.E. Diez. 1999. Population structure of hawksbill turtles on a foraging ground in the Dominican Republic. Chelonian Conservation and Biology 3(2):230-236.

Leonard, L.A., T.D. Clayton, and O.H. Pilkey. 1990. An analysis of replenished beach design parameters on U.S. East Coast barrier islands. Journal of Coastal Research 6(1):15-36.

Limpus. C.J. 1971. Sea turtle ocean finding behaviour. Search 2(10):385-387.

Limpus, C.J. 1997. Marine turtle populations of Southeast Asia and the western Pacific Region: distribution and status. Pages 37-72 in Noor, Y.R.., I.R. Lubis, R. Ounsted, S. Troeng, and A. Abdullah (editors). Proceedings of the Workshop on Marine Turtle Research and Management in Indonesia. Wetlands International, PHPA/Environment Australia, Bogor, Indonesia.

Limpus, C.J. 2002. Western Australia marine turtle review. Unpublished report to Western Austalian Department of Conservation and Land Management.

Limpus, C.J. 2004. A biological review of Australian marine turtles. iii. hawksbill turtle, *Eretmochelys imbricata* (Linnaeus). Department of Environment and Heritage and Queensland Environmental Protection Agency.

Limpus, C.J., V. Baker, and J.D. Miller. 1979. Movement induced mortality of loggerhead eggs. Herpetologica 35(4):335-338.

Limpus, C., J.D. Miller, and C.J. Parmenter. 1993. The northern Great Barrier Reef green turtle *Chelonia mydas* breeding population. Pages 47-50 *in* Smith, A.K. (compiler), K.H. Zevering and C.E. Zevering (editors). Raine Island and Environs Great Barrier Reef: Quest to Preserve a Fragile Outpost of Nature. Raine Island Corporation and Great Barrier Reef Marine Park Authority, Townsville, Queensland, Australia.

Lindström, Å., and J. Agrell. 1999. Global change and possible effects on the migration and reproduction of Arctic-breeding waders. Ecological Bulletins 47:145-159.

Loegering, J.P. 1992. Piping plover breeding biology, foraging ecology and behavior on Assateague Island National Seashore, Maryland. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Lohmann, K. J., Witherington, B. E., Lohmann, C. M. F. and Salmon, M. 1997. Orientation, navigation, and natal beach homing in sea turtles. In The Biology of Sea Turtles (ed. P. Lutz and J. Musick), pp. 107-136. Boca Raton: CRC Press.

Lohmann, K.J. and C.M.F. Lohmann. 2003. Orientation mechanisms of hatchling loggerheads. Pages 44-62 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Lott, C.A., P.A. Durkee, W.A. Gierhart, and P.P. Kelly. 2009a. Florida coastal engineering and bird conservation geographic information system (GIS) manual. US Army Corps of Engineers, Dredging Operations and Environmental Research Program, Engineer Research and Development Center, Technical Report, 42 pp.

Lott, C.A., C.S. Ewell Jr., and K.L. Volansky. 2009b. Habitat associations of shoreline-dependent birds in barrier island ecosystems during fall migration in Lee County, Florida. Prepared for U.S. Army Corps of Engineers, Engineer Research and Development Center, Technical Report. 103 pp.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impacts on sea turtle survival. Pages 387-409 in Lutz, P.L. and J.A. Musick (editors). The Biology of Sea Turtles. CRC Press. Boca Raton, Florida.

MacIvor, L.H. 1990. Population dynamics, breeding ecology, and management of piping plovers on outer Cape Cod, Massachusetts. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts.

Maddock, S. B. 2008. Wintering piping plover surveys 2006 2007, East Grand Terre, LA to Boca Chica, TX, December 20, 2006 – January 10, 2007, final report. Unpublished report prepared for the Canadian Wildlife Service, Environment Canada, Edmonton, Alberta. iv + 66 pp.

Maddock, S., M. Bimbi, and W. Golder. 2009. South Carolina shorebird project, draft 2006 – 2008 piping plover summary report. Audubon North Carolina and U.S. Fish and Wildlife Service, Charleston, South Carolina. 135 pp.

Mann, T.M. 1977. Impact of developed coastline on nesting and hatchling sea turtles in southeastern Florida. Unpublished Master of Science thesis. Florida Atlantic University, Boca Raton, Florida.

Margaritoulis, D., R. Argano, I. Baran, F. Bentivegna, M.N. Bradai, J.A. Camiñas, P. Casale, G. De Metrio, A. Demetropoulos, G. Gerosa, B.J. Godley, D.A. Haddoud, J. Houghton, L. Laurent, and B. Lazar. 2003. Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. Pages 175-198 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Marquez-Millan, R. 1994. Synopsis of biological data on the Kemp's ridley sea turtle, *Lepidochelys kempi* (Garman, 1880). NOAA Technical Memorandum NMFS-SEFC-343.

Márquez, M.R., A. Villanueva O., and M. Sánchez P. 1982. The population of the Kemp's ridley sea turtle in the Gulf of Mexico – *Lepidochelys kempii.* Pages 159-164 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles. Washington, D.C. Smithsonian Institute Press.

Marquez-Millan, R., A. Villanueva O., and P.M. Burchfield. 1989. Nesting population and production of hatchlings of Kemp's ridley sea turtle at Rancho Nuevo, Tamaulipas, Mexico. Pages 16-19 *in* Caillouet, Jr., C.W. and A.M. Landry, Jr. (editors). Proceedings of the First international Symposium on Kemp's Ridley Sea Turtle Biology, Conservation, and Management. Texas A&M University, Sea Grant Program. TAMU-SG-89-105. College Station, Texas.

Marquez, M.R., M.A. Carrasco, C. Jimenez, R.A. Byles, P. Burchfield, M. Sanchez, J. Diaz, and A.S. Leo. 1996. Good news! Rising numbers of Kemp's ridleys nest at Rancho Nuevo, Tamaulipas, Mexico. Marine Turtle Newsletter 73:2-5.

Martin, R.E. 1992. Turtle nest relocation on Jupiter Island, Florida: an evaluation. Presentation to the Fifth Annual National Conference on Beach Preservation Technology, February 12-14, 1992, St. Petersburg, Florida.

McConnaughey, J.L., J.D. Fraser, S.D. Coutu, and J.P. Loegering. 1990. Piping plover distribution and reproductive success on Cape Lookout National Seashore. Unpublished report to National Park Service.

McDonald, D.L. and P.H. Dutton. 1996. Use of PIT tags and photoidentification to revise remigration estimates of leatherback turtles (*Dermochelys coriacea*) nesting in St. Croix, U.S. Virgin Islands, 1979-1995. Chelonian Conservation and Biology 2(2):148-152.

McGehee, M.A. 1990. Effects of moisture on eggs and hatchlings of loggerhead sea turtles (*Caretta caretta*). Herpetologica 46(3):251-258.

McGowan, C.P., J.E. Hines, J.D. Nichols, J.E. Lyons, D.R. Smith, K.S. Kalasz, L.J. Niles, A.D. Dey, N.A. Clark, P.W. Atkinson, and et al. 2011. Demographic consequences of migratory stopover: Linking red knot survival to horseshoe crab spawning abundance. Ecosphere 2(6):1-22.

Meltofte, H., T. Piersma, H. Boyd, B. McCaffery, B. Ganter, V.V. Golovnyuk, K. Graham, C.L. Gratto-Trevor, R.I.G. Morrison, E. Nol, and et al. 2007. Effects of climate variation on the breeding ecology of Arctic shorebirds. Meddelelser om Grønland, Bioscience 59. Danish Polar Center, Copenhagen, Available at <http://www.worldwaders.org/dokok/literature/125/effects_of_climate_on_arctic_shorebirds_mog_biosci_59_2007.pdf>.

Melvin, S.M., C.R. Griffin, and L.H. MacIvor. 1991. Recovery strategies for piping plovers in Managed coastal landscapes. Coastal Management 19: 21-34.

Meylan, A. 1982. Estimation of population size in sea turtles. Pages 135-138 in Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Meylan, A. 1992. Hawksbill turtle *Eretmochelys imbricata*. Pages 95-99 *in* Moler, P.E. (editor). Rare and Endangered Biota of Florida, Volume III. University Press of Florida, Gainesville, Florida.

Meylan, A. 1995. Fascimile dated April 5, 1995, to Sandy MacPherson, National Sea Turtle Coordinator, U.S. Fish and Wildlife Service, Jacksonville, Florida. Florida Department of Environmental Protection. St. Petersburg, Florida.

Meylan, A.B. 1999. Status of the hawksbill turtle (*Eretmochelys imbricata*) in the Caribbean region. Chelonian Conservation and Biology 3(2):177-184.

Meylan, A.B. and M. Donnelly. 1999. Status justification for listing the hawksbill turtle (*Eretmochelys imbricata*) as critically endangered on the 1996 IUCN *Red List of Threatened Animals*. Chelonian Conservation and Biology 3(2):200-224.

Meylan, A., B. Schroeder, and A. Mosier. 1995. Sea turtle nesting activity in the State of Florida 1979-1992. Florida Marine Research Publications Number 52, St. Petersburg, Florida.

Meyer, S.R., J. Burger, and L.J. Niles. 1999. Habitat use, spatial dynamics, and stopover ecology of red knots on Delaware Bay. Unpublished report to the New Jersey Endangered and Nongame Species Program, Division of Fish and Wildlife, Trenton, NJ.

Miller, K., G.C. Packard, and M.J. Packard. 1987. Hydric conditions during incubation influence locomotor performance of hatchling snapping turtles. Journal of Experimental Biology 127:401-412.

Moody, K. 1998. The effects of nest relocation on hatching success and emergence success of the loggerhead turtle (*Caretta caretta*) in Florida. Pages 107-108 *in* Byles, R. and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Moran, K.L., K.A. Bjorndal, and A.B. Bolten. 1999. Effects of the thermal environment on the temporal pattern of emergence of hatchling loggerhead turtles *Caretta caretta*. Marine Ecology Progress Series 189:251-261.

Morrison, R.I.G., and R.K. Ross. 1989. Atlas of Nearctic shorebirds on the coast of South America in two volumes. Canadian Wildlife Service, Ottawa, Canada.

Morrison, R.I.G., K. Ross, and L.J. Niles. 2004. Declines in wintering populations of red knots in southern South America. The Condor 106:60-70.

Morrison, R.I.G. 2006. Body transformations, condition, and survival in red knots *Calidris canutus* travelling to breed at Alert, Ellesmere Island, Canada. Ardea 94(3):607-618.

Morrison, R.I.G., and B.A. Harrington. 1992. The migration system of the red knot *Calidris canutus* in the New World. Wader Study Group Bulletin 64:71-84.

Mortimer, J.A. 1982. Factors influencing beach selection by nesting sea turtles. Pages 45-51 in K.A. Bjorndal, ed. Biology and conservation of sea turtles. Smithsonian Institution Press; Washington, D.C.

Mortimer, J.A. 1990. The influence of beach sand characteristics on the nesting behavior and clutch survival of green turtles (*Chelonia mydas*). Copeia 1990: 802-817.

Morton, R.A. 2003. An overview of coastal land loss: With emphasis on the southeastern United States. USGS Open File Report 03-337. U.S. Geological Survey Center for Coastal and Watershed Studies, St. Petersburg, FL, Available at <http://pubs.usgs.gov/of/2003/of03-337/pdf.html>.

Morton, R., G. Tiling, and N. Ferina. 2003. Causes of hot-spot wetland loss in the Mississippi delta plain. Environmental Geosciences 10:71-80.

Mrosovsky, N. 1988. Pivotal temperatures for loggerhead turtles from northern and southern nesting beaches. Canadian Journal of Zoology 66:661-669.

Mrosovsky, N. and A. Carr. 1967. Preference for light of short wavelengths in hatchling green sea turtles (*Chelonia mydas*), tested on their natural nesting beaches. Behavior 28:217-231.

Mrosovsky, N. and J. Provancha. 1989. Sex ratio of hatchling loggerhead sea turtles: data and estimates from a five year study. Canadian Journal of Zoology 70:530-538.

Mrosovsky, N. and S.J. Shettleworth. 1968. Wavelength preferences and brightness cues in water finding behavior of sea turtles. Behavior 32:211-257.

Mrosovsky, N. and C.L. Yntema. 1980. Temperature dependence of sexual differentiation in sea turtles: implications for conservation practices. Biological Conservation 18:271-280.

Murphy, T.M. and S.R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. Unpublished report prepared for the National Marine Fisheries Service.

Musick, J.A. 1999. Ecology and conservation of long-lived marine mammals. Pages 1-10 *in* Musick, J.A. (editor). Life in the Slow Lane: Ecology and Conservation of Long-lived Marine Animals. American Fisheries Society Symposium 23, Bethesda, Maryland.

National Marine Fisheries Service. 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-455.

National Marine Fisheries Service. 2009a. Loggerhead Sea Turtles (*Caretta caretta*). National Marine Fisheries Service, Office of Protected Resources. Silver Springs, Maryland. http://www.nmfs.noaa.gov/pr/species/turtles/loggerhead.htm

National Marine Fisheries Service. 2009b. Green Sea Turtles (*Chelonia mydas*). National Marine Fisheries Service, Office of Protected Resources. Silver Springs, Maryland. http://www.nmfs.noaa.gov/pr/species/turtles/green.htm

National Marine Fisheries Service. 2009c. Leatherback Sea Turtles (*Dermochelys coriacea*). National Marine Fisheries Service, Office of Protected Resources. Silver Springs, Maryland. http://www.nmfs.noaa.gov/pr/species/turtles/leatherback.htm

National Marine Fisheries Service. 2009d. Hawksbill Turtles (*Eretmochelys imbricata*). National Marine Fisheries Service, Office of Protected Resources. Silver Springs, Maryland. http://www.nmfs.noaa.gov/pr/species/turtles/hawksbill.htm

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery plan for U.S. population of Atlantic green turtle (*Chelonia mydas*). National Marine Fisheries Service, Washington, D.C.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1992. Recovery plan for leatherback turtles (*Dermochelys coriacea*) in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service, Washington, D.C.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1993. Recovery plan for hawksbill turtle (*Eretmochelys imbricata*) in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service, St. Petersburg, Florida.

National Marine Fisheries Service and the U.S. Fish and Wildlife Service (NMFS and Service). 1998a. Recovery plan for U.S. Pacific populations of the green turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service and the U.S. Fish and Wildlife Service (NMFS and Service). 1998b. Recovery plan for U.S. Pacific populations of the hawksbill turtle (*Eretmochelys imbricata*). National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service and the U.S. Fish and Wildlife Service (NMFS and Service). 2007a. Green sea turtle (*Chelonia mydas*) 5-year review: summary and evaluation. 102 pages.

National Marine Fisheries Service and the U.S. Fish and Wildlife Service (NMFS and Service). 2007b. Leatherback sea turtle (*Dermochelys coriacea*) 5-year review: summary and evaluation. 79 pages.

National Marine Fisheries Service and the U.S. Fish and Wildlife Service (NMFS and Service). 2007c. Hawksbill sea turtle (*Eretmochelys imbricata*) 5-year review: summary and evaluation. 90 pages.

National Marine Fisheries Service and the U.S. Fish and Wildlife Service (NMFS and Service). 2008. Recovery plan for the Northwest Atlantic population of the loggerhead sea turtle (*Caretta caretta*), second revision. National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service, U.S. Fish and Wildlife Service, and SEMARNAT. 2011. Bi-national recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*), second revision. National Marine Fisheries Service, Silver Spring, Maryland.

National Oceanic and Atmospheric Administration [NOAA]. 2012. Linear mean sea level (MSL) trends and standard errors in mm/yr, Available at **<http://tidesandcurrents.noaa.gov/sltrends/msltrendstable.htm>.**

National Oceanic and Atmospheric Administration. 2013. Regional climate trends and scenarios for the U.S. national climate assessment. Part 1. Climate of the northeast U.S. NOAA technical report NESDIS 142-1. NOAA, Washington, DC, Available at <http://scenarios.globalchange.gov/report/regional-climate-trends-and-scenarios-us-national-climate-assessment-part-1-climate-northeast>.

National Park Service. 2007. Cape Hatteras National Seashore 2007 annual piping plover (*Charadrius melodus*) report. Cape Hatteras National Seashore, Manteo, North Carolina.

National Research Council. 1987. Responding to changes in sea level: Engineering Implications. National Academy Press, Washington, D.C.

National Research Council. 1990a. Decline of the sea turtles: causes and prevention. National Academy Press; Washington, D.C.

National Research Council. 1990b. Managing coastal erosion. National Academy Press; Washington, D.C.

National Research Council. 1995. Beach nourishment and protection. National Academy Press; Washington, D.C.

National Research Council. 2010. Advancing the science of climate change. The National Academies Press, Washington, DC, Available at <http://www.nap.edu/catalog.php?record_id=12782>.

Neal, W.J., O.H. Pilkey, and J.T. Kelley. 2007. Atlantic coast beaches: a guide to ripples, dunes, and other natural features of the seashore. Mountain Press Publishing Company, Missoula, Montana. 250 pages.

Nelson, D.A. 1987. The use of tilling to soften nourished beach sand consistency for nesting sea turtles. Unpublished report of the U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Nelson, D.A. 1988. Life history and environmental requirements of loggerhead turtles. U.S. Fish and Wildlife Service Biological Report 88(23). U.S. Army Corps of Engineers TR EL-86-2 (Rev.).

Nelson, D.A. and B. Blihovde. 1998. Nesting sea turtle response to beach scarps. Page 113 *in* Byles, R., and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Nelson, D.A. and D.D. Dickerson. 1987. Correlation of loggerhead turtle nest digging times with beach sand consistency. Abstract of the 7th Annual Workshop on Sea Turtle Conservation and Biology.

Nelson, D.A. and D.D. Dickerson. 1988a. Effects of beach nourishment on sea turtles. *In* Tait, L.S. (editor). Proceedings of the Beach Preservation Technology Conference '88. Florida Shore & Beach Preservation Association, Inc., Tallahassee, Florida.

Nelson, D.A. and D.D. Dickerson. 1988b. Hardness of nourished and natural sea turtle nesting beaches on the east coast of Florida. Unpublished report of the U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Nelson, D.A. and D.D. Dickerson. 1988c. Response of nesting sea turtles to tilling of compacted beaches, Jupiter Island, Florida. Unpublished report of the U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Nelson, D.A., K. Mauck, and J. Fletemeyer. 1987. Physical effects of beach nourishment on sea turtle nesting, Delray Beach, Florida. Technical Report EL-87-15. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Newstead, D.J., Niles, L.J., Porter, R.R., Dey, A.D., Burger, J. & Fitzsimmons, O.N. 2013. Geolocation reveals mid-continent migratory routes and Texas wintering areas of Red Knots (*Calidris canutus rufa*). Wader Study Group Bull. 120(1): 53–59.

Nielsen, J.T. 2010. Population structure and the mating system of loggerhead turtles (*Caretta caretta*). Open Access Dissertations. Paper 507. http://scholarlyrepository.miami.edu/oa_dissertations/507

Nicholas, M. Electronic mail dated 8 March 2005 from Mark Nicholas, Gulf Islands National Seashore, Gulf Breeze, Florida to Patricia Kelly, USFWS, Panama City, Florida Field Office providing documentation of Great Lakes piping plover sightings post-hurricane.

Nicholls, J.L. 1989. Distribution and other ecological aspects of piping plovers (Charadrius melodus) wintering along the Atlantic and Gulf Coasts. M.S. Thesis. Auburn University, Auburn, Alabama.

Nicholls, J.L. and G.A. Baldassarre. 1990a. Habitat selection and interspecific associations of piping plovers along the Atlantic and Gulf Coasts of the United States. M.S. Thesis. Auburn University, Auburn, Alabama.

Niles, L.J., H.P. Sitters, A.D. Dey, P.W. Atkinson, A.J. Baker, K.A. Bennett, R. Carmona, K.E. Clark, N.A. Clark, and C. Espoza. 2008. Status of the red knot (*Calidris canutus rufa*) in the Western Hemisphere. Studies in Avian Biology 36:1-185.

Niles, L.J. 2010. Blog - a rube with a view: Delaware Bay update 5/28/10-The importance of good habitat, Available at <http://www.arubewithaview.com/blog/2010/5/29/delaware-bay-update-52810-the-importance-of-good-habitat.html>.

Niles, L.J. 2012. Blog - a rube with a view: Unraveling the Texas knot, Available at <http://arubewithaview.com/2012/05/01/unraveling-the-texas-knot/>.

Niles, L.J., J. Burger, R.R. Porter, A.D. Dey, S. Koch, B. Harrington, K. Iaquinto, and M. Boarman. 2012. Migration pathways, migration speeds and non-breeding areas used by northern hemisphere wintering red knots *Calidris canutus* of the subspecies *rufa*. Wader Study Group Bull. 119(2): 195-203.

Niles, L. 2013. Consulting Biologist/Leader. E-mails of January 4, 8, and 25, and March 15, 2013. International Shorebird Project, Conserve Wildlife Foundation of New Jersey. Greenwich, NJ.

Niles, L., L. Tedesco, D. Daly, and T. Dillingham. 2013. Restoring Reeds, Cooks, Kimbles and Pierces Point Delaware Bay beaches, NJ, for shorebirds and horseshoe crabs. Unpublished draft project proposal.

Noel, B.L., C.R. Chandler, and B. Winn. 2005. Report on migrating and wintering Piping Plover activity on Little St. Simons Island, Georgia in 2003-2004 and 2004-2005. Report to U.S. Fish and Wildlife Service.

Noel, B.L., C.R. Chandler, and B. Winn. 2007. Seasonal abundance of nonbreeding piping plovers on a Georgia barrier island. Journal of Field Ornithology 78:420-427.

Noel, B. L., and C. R. Chandler. 2008. Spatial distribution and site fidelity of non-breeding piping plovers on the Georgia coast. Waterbirds 31:241-251.

Nordstrom, K.F. 2000. Beaches and dunes of developed coasts. Cambridge University Press, Cambridge, UK.

Nordstrom, K.F., and M.N. Mauriello. 2001. Restoring and maintaining naturally-functioning landforms and biota on intensively developed barrier islands under a no-retreat alternative. Shore & Beach 69(3):19-28.

Nordstrom, K.F., N.L. Jackson, A.H.F. Klein, D.J. Sherman, and P.A. Hesp. 2006. Offshore aoelian transport across a low foredune on a developed barrier island. Journal of Coastal Research. Volume 22., No. 5. pp1260-1267.

North Carolina Office of Budget and Management. Municipal population estimates. Available at http://www.osbm.state.nc.us/ncosbm/facts_and_figures/socioeconomic_data/population_estimates/municipal_estimates.shtm. Accessed May 28, 2014.

Nudds, R.L. and D.M. Bryant. 2000. The energetic cost of short flight in birds. Journal of Experimental Biology 203:1561-1572.

Ogren, L.H. 1989. Distribution of juvenile and subadult Kemp's ridley turtles: preliminary results from the 1984-1987 surveys. Pages 116-123 *in* Caillouet, C.W., Jr., and A.M. Landry, Jr. (eds.). Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. Texas A&M University Sea Grant College Program TAMU-SG-89-105.

Packard, M.J. and G.C. Packard. 1986. Effect of water balance on growth and calcium mobilization of embryonic painted turtles (*Chrysemys picta*). Physiological Zoology 59(4):398-405.

Packard, G.C., M.J. Packard, and T.J. Boardman. 1984. Influence of hydration of the environment on the pattern of nitrogen excretion by embryonic snapping turtles (*Chelydra serpentina*). Journal of Experimental Biology 108:195-204.

Packard, G.C., M.J. Packard, and W.H.N. Gutzke. 1985. Influence of hydration of the environment on eggs and embryos of the terrestrial turtle *Terrapene ornata*. Physiological Zoology 58(5):564-575.

Packard,G.C., M.J. Packard, T.J. Boardman, and M.D. Ashen. 1981. Possible adaptive value of water exchange in flexible-shelled eggs of turtles. Science 213:471-473.

Packard G.C., M.J. Packard, K. Miller, and T.J. Boardman. 1988. Effects of temperature and moisture during incubation on carcass composition of hatchling snapping turtles (*Chelydra serpentina*). Journal of Comparative Physiology B 158:117-125.

Palmer, R.S. 1967. Piping plover. In: Stout, G.D. (editor), The shorebird of North America. Viking Press, New York. 270 pp.

Parmenter, C.J. 1980. Incubation of the eggs of the green sea turtle, *Chelonia mydas*, in Torres Strait, Australia: the effect of movement on hatchability. Australian Wildlife Research 7:487-491.

Patrick, L. 2012. Biologist. E-mails of August 31, and October 22, 2012. U.S. Fish and Wildlife Service, Southeast Region. Panama City, FL.

Penland, S., and K. Ramsey. 1990. Relative sea level rise in Louisiana and the Gulf of Mexico: 1908-1988. Journal of Coastal Resources 6:323-342.

Perkins, S. 2008. Perkins, S. 2008. "South Beach PIPLs", 29 September 2008. electronic correspondence (30 September 2008) NEFO.

Peters, K.A., and D.L. Otis. 2007. Shorebird roost-site selection at two temporal scales: Is human disturbance a factor? Journal of Applied Ecology 44:196-209.

Peterson, C.H., and M.J. Bishop. 2005. Assessing the environmental impacts of beach nourishment. BioScience 55(10):887-896.

Peterson, C.H., and L. Manning. 2001. How beach nourishment affects the habitat value of intertidal beach prey for surf fish and shorebirds and why uncertainty still exists. Pages 2 In Proceedings of the coastal ecosystems & federal activities technical training symposium, August 20-22, 2001, Available at <http://www.fws.gov/nc-es/ecoconf/ppeterson%20abs.pdf>.

Pfeffer, W.T., J.T. Harper, and S. O'Neel. 2008. Kinematic constraints on glacier contributions to 21st-century sea-level rise. Science 321(5894):1340-1343.

Pfister, C., B.A. Harrington, and M. Lavine. 1992. The impact of human disturbance on shorebirds at a migration staging area. Biol. Conserv. 60:115-126.

Philibosian, R. 1976. Disorientation of hawksbill turtle hatchlings (*Eretmochelys imbricata*) by stadium lights. Copeia 1976:824.

Philippart, C.J.M., H.M. van Aken, J.J. Beukema, O.G. Bos, G.C. Cadée, and R. Dekker. 2003. Climate-related changes in recruitment of the bivalve Macoma balthica. Limnology and Oceanography 48(6):2171-2185.

Piersma, T., and A.J. Baker. 2000. Life history characteristics and the conservation of migratory shorebirds. Pages 105-124 In L.M. Gosling, and W.J. Sutherland, eds. Behaviour and Conservation, Cambridge University Press, Cambridge, UK.

Piersma, T., and Å. Lindström. 2004. Migrating shorebirds as integrative sentinels of global environmental change. Ibis 146 (Suppl.1):61-69.

Piersma, T., G.A. Gudmundsson, and K. Lilliendahl. 1999. Rapid changes in the size of different functional organ and muscle groups during refueling in a long-distance migrating shorebird. Physiological and Biochemical Zoology 72(4):405-415.

Piersma, T., and J.A. van Gils. 2011. The flexible phenotype. A body-centred integration of ecology, physiology, and behavior. Oxford University Press Inc., New York.

Pilcher, N. J., Enderby, J. S., Stringell, T. and Bateman, L. 2000. Nearshore turtle hatchling distribution and predation. In Sea Turtles of the Indo-Pacific: Research, Management and Conservation (ed. N. J. Pilcher and M. G. Ismai), pp.151 -166. New York: Academic Press.

Pilkey, O.H. and K.L. Dixon. 1996. The Corps and the shore. Island Press; Washington, D.C.

Pilkey, O.H. and H.L. Wright III. 1988. Seawalls versus beaches. Journal of Coastal Research, Special Issue 4:41-64.

Pilkey, Jr., O.H., D.C. Sharma, H.R. Wanless, L.J. Doyle, O.H. Pilkey, Sr., W. J. Neal, and B.L. Gruver. 1984. Living with the East Florida Shore. Duke University Press, Durham, North Carolina.

Plant, N.G. and G.B. Griggs. 1992. Interactions between nearshore processes and beach morphology near a seawall. Journal of Coastal Research 8(1): 183-200.

Pompei, V. D., and F. J. Cuthbert. 2004. Spring and fall distribution of piping plovers in North America: implications for migration stopover conservation. Report the U.S. Army Corps of Engineers. University of Minnesota, St. Paul.

Possardt, E. 2005. Personal communication to Sandy MacPherson, U.S. Fish and Wildlife Service, Jacksonville, Florida. U.S. Fish and Wildlife Service, Atlanta, GA.

Potter, E.F., J.F. Parnell, and R.P. Teulings. 1980. Birds of the Carolinas. University of North Carolina Press. 402 pages.

Pritchard, P.C.H. 1982. Nesting of the leatherback turtle, *Dermochelys coriacea* in Pacific Mexico, with a new estimate of the world population status. Copeia 1982(4):741-747.

Pritchard, P.C.H. 1992. Leatherback turtle *Dermochelys coriacea*. Pages 214-218 *in* Moler, P.E. (editor). Rare and Endangered Biota of Florida, Volume III. University Press of Florida; Gainesville, Florida.

Pritchard, P.C.H. and R. Márquez M. 1973. Kemp's ridley or Atlantic ridley, *Lepidochelys kempii*. IUCN Monograph No. 2. (Marine Turtle Series).

Provancha, J.A. and L.M. Ehrhart. 1987. Sea turtle nesting trends at Kennedy Space Center and Cape Canaveral Air Force Station, Florida, and relationships with factors influencing nest site selection. Pages 33-44 *in* Witzell, W.N. (editor). Ecology of East Florida Sea Turtles: Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop. NOAA Technical Report NMFS-53.

Putman, N.F., T.J. Shay, and K.J. Lohmann. 2010. Is the geographic distribution of nesting in the Kemp's ridley turtle shaped by the migratory needs of offspring? Integrative and Comparative Biology, a symposium presented at the annual meeting of the Society for Integrative and Comparative Biology, Seattle, WA. 10 pages.

Rabon, D.R., Jr., S.A. Johnson, R. Boettcher, M. Dodd, M. Lyons, S. Murphy, S. Ramsey, S. Roff, and K. Stewart. 2003. Confirmed leatherback turtle (*Dermochelys coriacea*) nests from North Carolina, with a summary of leatherback nesting activities north of Florida. Marine Turtle Newslettter 101:4-8.

Radford, A. E., H. E. Ahles, and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill, NC.

Raymond, P.W. 1984. The effects of beach restoration on marine turtles nesting in south Brevard County, Florida. Unpublished Master of Science thesis. University of Central Florida, Orlando, Florida.

Rehfisch, M.M., and H.Q.P. Crick. 2003. Predicting the impact of climatic change on Arctic-breeding waders. Wader Study Group Bulletin 100:86-95.

Reina, R.D., P.A. Mayor, J.R. Spotila, R. Piedra, and F.V. Paladino. 2002. Nesting ecology of the leatherback turtle, *Dermochelys coriacea*, at Parque Nacional Marino Las Baulas, Costa Rica: 1988-1989 to 1999-2000. Copeia 2002(3):653-664.

Rice, T.M. 2009. Best management practices for shoreline stabilization to avoid and minimize adverse environmental impacts. Unpublished report prepared for the USFWS, Panama City Ecological Services Field Office, Available at http://www.fws.gov/charleston/pdf/PIPL/BMPs%20For%20Shoreline%20Stabilization%20To%20Avoid%20And%20Minimize%20Adverse%20Environmental%20Impacts.pdf.

Richardson, T.H., J.I. Richardson, C. Ruckdeschel, and M.W. Dix. 1978. Remigration patterns of loggerhead sea turtles (*Caretta caretta*) nesting on Little Cumberland Island and Cumberland Island, Georgia. Pages 39-44 *in* Henderson, G.E. (editor). Proceedings of the Florida and Interregional Conference on Sea Turtles. Florida Marine Research Publications Number 33.

Richardson, J.I., R. Bell, and T.H. Richardson. 1999. Population ecology and demographic implications drawn from an 11-year study of nesting hawksbill turtles, *Eretmochelys imbricata*, at Jumby Bay, Long Island, Antigua, West Indies. Chelonian Conservation and Biology 3(2):244-250.

Roche, E.A., J.B. Cohen, D.H. Catlin, D.L. Amirault, F.J. Cuthbert, C.L. Gratto-Trevor, J, Felio, and J.D. Fraser. 2009. Range-wide estimation of apparent survival in the piping plover. Report submitted to the U.S. Fish and Wildlife Service, East Lansing, Michigan.

Ross, J.P. 1979. Sea turtles in the Sultanate of Oman. World Wildlife Fund Project 1320. May 1979 report. 53 pages.

Ross, J.P. 1982. Historical decline of loggerhead, ridley, and leatherback sea turtles. Pages 189-195 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles. Smithsonian Institution Press; Washington, D.C.

Ross, J.P. and M.A. Barwani. 1995. Review of sea turtles in the Arabian area. Pages 373-383 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles, Revised Edition. Smithsonian Institution Press, Washington, D.C. 615 pages.

Rostal, D.C. 2007. Reproductive physiology of the ridley sea turtle. Pages 151-165 *in* Plotkin P.T. (editor). Biology and Conservation of Ridley Sea Turtles. Johns Hopkins University Press, Baltimore, Maryland.

Routa, R.A. 1968. Sea turtle nest survey of Hutchinson Island, Florida. Quarterly Journal of the Florida Academy of Sciences 30(4):287-294.

Rumbold, D.G., P.W. Davis, and C. Perretta. 2001. Estimating the effect of beach nourishment on *Caretta caretta* (loggerhead sea turtle) nesting. Restoration Ecology 9(3):304-310.

Sallenger, A.H. Jr., C.W. Wright, P. Howd, and K. Doran. 2009 in review. Barrier island failure modes triggered by Hurricane Katrina: implications for future sea-level-rise impacts. Submitted to Geology.

Salmon, M. and J. Wyneken. 1987. Orientation and swimming behavior of hatchling loggerhead turtles *Caretta caretta* L. during their offshore migration. J. Exp. Mar. Biol. Ecol. 109: 137–153.

Salmon, M., J. Wyneken, E. Fritz, and M. Lucas. 1992. Seafinding by hatchling sea turtles: role of brightness, silhouette and beach slope as orientation cues. Behaviour 122 (1-2):56-77.

Scavia, D., J.C. Field, D.F. Boesch, R.W. Buddemeier, V. Burkett, D.R. Cayan, M. Fogarty, M.A. Harwell, R.W. Howarth, C. Mason, D.J. Reed, T.C. Royer, A.H. Sallenger, and J.G. Titus. 2002. Climate change impacts on U.S. coastal and marine ecosystems. Estuaries 25:149-164.

Schlacher, T.A., and L.M.C. Thompson. 2008. Physical impacts caused by off-road vehicles (ORVs) to sandy beaches: Spatial quantification of car tracks on an Australian barrier island. Journal of Coastal Research 24:234-242.

Schmidt, N.M., R.A. Ims, T.T. Høye, O. Gilg, L.H. Hansen, J. Hansen, M. Lund, E. Fuglei, M.C. Forchhammer, and B. Sittler. 2012. Response of an arctic predator guild to collapsing lemming cycles. Proceedings of the Royal Society B 279:4417-4422.

Schmitt, M.A. and A. C. Haines. 2003. Proceeding of the 2003 Georgia Water Resources Conference April 23-24, 2003, at the University of Georgia.

Schneider, T.M., and B. Winn. 2010. Georgia species account: Red knot (*Calidris canutus*). Unpublished report by the Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation Section, Available at <http://www.georgiawildlife.com/sites/default/files/uploads/wildlife/nongame/pdf/accounts/birds/calidris_canutus.pdf>.

Schroeder, B.A. 1981. Predation and nest success in two species of marine turtles (*Caretta caretta* and *Chelonia mydas*) at Merritt Island, Florida. Florida Scientist 44(1):35.

Schroeder, B.A. 1994. Florida index nesting beach surveys: are we on the right track? Pages 132-133 *in* Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar (compilers). Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351.

Schroeder, B.A., A.M. Foley, and D.A. Bagley. 2003. Nesting patterns, reproductive migrations, and adult foraging areas of loggerhead turtles. Pages 114-124 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Schroeder, B.A. and A.E. Mosier. 1996. Between a rock and a hard place: coastal armoring and marine turtle nesting habitat in Florida. Proceedings of the 18th International Sea Turtle Symposium (Supplement, 16th Annual Sea Turtle Symposium Addemdum). NOAA Technical Memorandum.

Schwarzer, A.C., J.A. Collazo, L.J. Niles, J.M. Brush, N.J. Douglass, and H.F. Percival. 2012. Annual survival of red knots (*Calidris canutus rufa*) wintering in Florida. The Auk 129(4):725-733.

Scott, J.A. 2006. Use of satellite telemetry to determine ecology and management of loggerhead turtle (*Caretta caretta*) during the nesting season in Georgia. Unpublished Master of Science thesis. University of Georgia, Athens, Georgia.

Shaver, D.J. 2002. Research in support of the restoration of sea turtles and their habitat in national seashores and areas along the Texas coast, including the Laguna Madre. Final NRPP Report. U.S. Geological Survey, Department of the Interior.

Shaver, D.J. 2005. Analysis of the Kemp's ridley imprinting and headstart project at Padre Island National Seashore, Texas, 1978-88, with subsequent nesting and stranding records on the Texas coast. Chelonian Conservation and Biology 4(4):846-859.

Shaver, D.J. 2006a. Kemp's ridley sea turtle project at Padre Island National Seashore and Texas sea turtle nesting and stranding 2004 report. National Park Service, Department of the Interior.

Shaver, D.J. 2006b. Kemp's ridley sea turtle project at Padre Island National Seashore and Texas sea turtle nesting and stranding 2005 report. National Park Service, Department of the Interior.

Shaver, D.J. 2007. Texas sea turtle nesting and stranding 2006 report. National Park Service, Department of the Interior.

Shaver, D.J. 2008. Texas sea turtle nesting and stranding 2007 report. National Park Service, Department of the Interior.

Shaver, D.J. and C.W. Caillouet, Jr. 1998. More Kemp's ridley turtles return to south Texas to nest. Marine Turtle Newsletter 82:1-5.

Shaver, D. 2008. Personal communication via e-mail to Sandy MacPherson, U.S. Fish and Wildlife Service, Jacksonville, Florida, on Kemp's ridley sea turtle nesting in Texas in 2008. National Park Service.

Shuster, C.N.,Jr., R.B. Barlow, and J.H. Brockmann editors. 2003. The American horseshoe crab. Harvard University Press, Cambridge, MA.

Siok, D., and B. Wilson. 2011. Using dredge spoils to restore critical American horseshoe crab (*Limulus polyphemus*) spawning habitat at the Mispillion Inlet. Delaware Coastal Program, Dover, DE.

Skagen, S.K. 2006. Migration stopovers and the conservation of Arctic-breeding Calidridine sandpipers. The Auk 123:313-322.

Smith, B.S. 2007. 2006-2007 Nonbreeding shorebird survey, Franklin and Wakulla Counties, Florida. Final report to the USFWS in fulfillment of Grant #40181-7-J008. Apalachicola Riverkeeper, Apalachicola, Florida. 32 pp.

Smith, D.R., and S.F. Michels. 2006. Seeing the elephant: Importance of spatial and temporal coverage in a large-scale volunteer-based program to monitor horseshoe crabs. Fisheries 31(10):485-491.

Smith, D.R., N.L. Jackson, K.F. Nordstrom, and R.G. Weber. 2011. Beach characteristics mitigate effects of onshore wind on horseshoe crab spawning: Implications for matching with shorebird migration in Delaware Bay. Animal Conservation 14:575-584.

Snover, M.L., A.A. Hohn, L.B. Crowder, and S.S. Heppell. 2007. Age and growth in Kemp's ridley sea turtles: evidence from mark-recapture and skeletochronology. Pages 89-106 *in* Plotkin P.T. (editor). Biology and Conservation of Ridley Sea Turtles. John Hopkins University Press, Baltimore, Maryland.

Snover, M. 2005. Personal communication to the Loggerhead Sea Turtle Recovery Team. National Marine Fisheries Service.

Sobel, D. 2002. A photographic documentation of aborted nesting attempts due to lounge chairs. Page 311 *in* Mosier, A., A. Foley, and B. Brost (compilers). Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Solow, A.R., K.A. Bjorndal, and A.B. Bolten. 2002. Annual variation in nesting numbers of marine turtles: the effect of sea surface temperature on re-migration intervals. Ecology Letters 5:742-746.

South Carolina Department of Natural Resources (SCDNR). 2012. Interim performance report, October 1, 2011-September 30, 2012, South Carolina USFWS Project E-1, Segment 34 (F11AP00805).

Spaans, A.L. 1978. Status and numerical fluctuations of some North American waders along the Surinam coast. Wilson Bulletin 90:60-83.

Spotila, J.R., E.A. Standora, S.J. Morreale, G.J. Ruiz, and C. Puccia. 1983. Methodology for the study of temperature related phenomena affecting sea turtle eggs. U.S. Fish and Wildlife Service Endangered Species Report 11.

Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: are leatherback turtles going extinct? Chelonian Conservation and Biology 2(2):290-222.

Spotila, J.R. R.D. Reina, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 2000. Pacific leatherback turtles face extinction. Nature 405:529-530.

Staine, K.J., and J. Burger. 1994. Nocturnal foraging behavior of breeding piping plovers (Charadrius melodus) in New Jersey. Auk 111:579-587

Stancyk, S.E., O.R. Talbert, and J.M. Dean. 1980. Nesting activity of the loggerhead turtle *Caretta caretta* in South Carolina, II: protection of nests from raccoon predation by transplantation. Biological Conservation 18:289-298.

Stancyk, S.E. 1995. Non-human predators of sea turtles and their control. Pages 139-152 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles, Revised Edition. Smithsonian Institution Press. Washington D.C.

Steinitz, M.J., M. Salmon, and J. Wyneken. 1998. Beach renourishment and loggerhead turtle reproduction: a seven year study at Jupiter Island, Florida. Journal of Coastal Research 14(3):1000-1013.

Sternberg, J. 1981. The worldwide distribution of sea turtle nesting beaches. Center for Environmental Education, Washington, D.C.

Stewart, K.R. 2007. Establishment and growth of a sea turtle rookery: the population biology of the leatherback in Florida. Unpublished Ph.D. dissertation. Duke University, Durham, North Carolina. 129 pages.

Stewart, K. and C. Johnson. 2006. *Dermochelys coriacea*-Leatherback sea turtle. In Meylan, P.A. (editor). Biology and Conservation of Florida Turtles. Chelonian Research Monographs 3:144-157.

Stewart, K.R. and J. Wyneken. 2004. Predation risk to loggerhead hatchlings at a high-density nesting beach in Southeast Florida. Bulletin of Marine Science 74(2):325-335.

Stewart, K., M. Sims, A. Meylan, B. Witherington, B. Brost, and L.B. Crowder. 2011. Leatherback nests increasing significantly in Florida, USA; trends assessed over 30 years using multilevel modeling. Ecological Applications 21(1):263-273.

Stone, W. 1937. Bird studies at Old Cape May: An ornithology of coastal New Jersey. Dover Publications, New York.

Stucker, J.H. and F.J. Cuthbert. 2004. Piping plover breeding biology and management in the Great Lakes, 2004. Report submitted to the US Fish and Wildlife Service, East Lansing, MI.

Stucker, J.H., and F.J. Cuthbert. 2006. Distribution of non-breeding Great Lakes piping plovers along Atlantic and Gulf of Mexico coastlines: 10 years of band resightings. Final Report to U.S. Fish and Wildlife Service.

Stucker, J.H., F.J. Cuthbert and C.D. Haffner. 2003. Piping plover breeding biology and management in the Great Lakes, 2003. Report submitted to the US Fish and Wildlife Service, East Lansing, MI.

Suiter, D. 2009. Electronic mail dated 2 February 2009 from Dale Suiter, USFWS, Raleigh, North Carolina Field Office to Patricia Kelly, USFWS, Panama City, Florida Field Office on February 2, 2009 regarding status of beach vitex and control measures along the North Carolina, South Carolina, and Georgia coast.

Summers, R.W., and L.G. Underhill. 1987. Factors related to breeding production of Brent Geese *Branta b. bernicla* and waders (*Charadrii*) on the Taimyr Peninsula. Bird Study 34:161-171.

Tait, J.F. and G.B. Griggs. 1990. Beach response to the presence of a seawall. Shore and Beach, April 1990:11-28.

Talbert, O.R., Jr., S.E. Stancyk, J.M. Dean, and J.M. Will. 1980. Nesting activity of the loggerhead turtle (*Caretta caretta*) in South Carolina I: a rookery in transition. Copeia 1980(4):709-718.

Tanacredi, J.T., M.L. Botton, and D. Smith. 2009. Biology and conservation of horseshoe crabs. Springer, New York.

Tarr, J.G., and P.W. Tarr. 1987. Seasonal abundance and the distribution of coastal birds on the northern Skeleton Coast, South West Africa/Nimibia. Madoqua 15, 63-72.

Tarr, N.M. 2008. Fall migration and vehicle disturbance of shorebirds at South Core Banks, North Carolina. North Carolina State University, Raleigh, NC.

Tebaldi, C., B.H. Strauss, and C.E. Zervas. 2012. Modelling sea level rise impacts on storm surges along US coasts. Environmental Research Letters 7:014032.

Thieler, E.R., and E.S. Hammar-Klose. 1999. National assessment of coastal vulnerability to sea-level rise: Preliminary results for the U.S. Atlantic coast. Open-file report 99-593. U.S. Geological Survey, Woods Hole, MA, Available at <http://pubs.usgs.gov/of/1999/of99-593/>.

Thieler, E.R., and E.S. Hammar-Klose. 2000. National assessment of coastal vulnerability to sea-level rise: Preliminary results for the U.S. Gulf of Mexico coast. Open-file report 00-179. U.S. Geological Survey, Woods Hole, MA, Available at <http://pubs.usgs.gov/of/2000/of00-179/>.

Thomas, K., R.G. Kvitek, and C. Bretz. 2002. Effects of human activity on the foraging behavior of sanderlings (*Calidris alba*). Biological Conservation 109:67-71.

Titus, J.G., and C. Richman. 2001. Maps of lands vulnerable to sea level rise: Modeled elevations along the U.S. Atlantic and Gulf coasts. Climatic Research 18:205-228

Titus, J.G. 1990. Greenhouse effect, sea level rise, and barrier islands: Case study of Long Beach Island, New Jersey. Coastal Management 18:65-90.

Terchunian, A.V. 1988. ITPting coastal armoring structures: can seawalls and beaches coexist? Journal of Coastal Research, Special Issue 4:65-75.

Tomas, J. and J.A. Raga. 2007. Occurrence of Kemp's ridley sea turtle (*Lepidochelys kempii*) in the Mediterranean. Journal of the Marine Biological Association of the United Kingdom 2. Biodiversity Records 5640. 3 pages.

Tremblay, T.A., J.S. Vincent, and T.R. Calnan. 2008. Status and trends of inland wetland and aquatic habitats in the Corpus Christi area. Final report under CBBEP Contract No. 0722 submitted to Coastal Bend Bays and Estuaries Program, Texas General Land Office, and National Oceanic and Atmospheric Administration.

Trindell, R. 2005. Sea turtles and beach nourishment. Florida Fish and Wildlife Conservation Commission, Imperiled Species Management Section. Invited Instructor, CLE Conference.

Trindell, R. 2007. Personal communication. Summary of lighting impacts on Brevard County beaches after beach nourishment. Florida Fish and Wildlife Conservation Commission, Imperiled Species Management Section, Tallahassee, Florida to Lorna Patrick, U. S. Fish and Wildlife Service, Panama City, Florida.

Trindell, R., D. Arnold, K. Moody, and B. Morford. 1998. Post-construction marine turtle nesting monitoring results on nourished beaches. Pages 77-92 in Tait, L.S. (compiler). Proceedings of the 1998 Annual National Conference on Beach Preservation Technology. Florida Shore & Beach Preservation Association, Tallahassee, Florida.

Truitt, B.R., B.D. Watts, B. Brown, and W. Dunstan. 2001. Red knot densities and invertebrate prey availability on the Virginia barrier islands. Wader Study Group Bulletin 95:12.

Turtle Expert Working Group . 1998. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409.

Turtle Expert Working Group. 2000. Assessment for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Technical Memorandum. NMFS-SEFSC-444.

Turtle Expert Working Group. 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555.

Turtle Expert Working Group. 2009. An assessment of the loggerhead turtle population in the Western North Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-575.

U.S. Army Corps of Engineers. 2012. Project factsheet: Delaware Bay coastline, DE & NJ, Reeds Beach and Pierces Point, NJ , Available at <http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6442/delaware-bay-coastline-de-nj-reeds-beach-and-pierces-point-nj.aspx

U.S. Climate Change Science Program. 2009. Coastal sensitivity to sea-level rise: A focus on the Mid-Atlantic Region. U.S. Climate Change Science Program synthesis and assessment product 4.1. U.S. Geological Survey, Reston, VA, Available at <http://downloads.globalchange.gov/sap/sap4-1/sap4-1-final-report-all.pdf>.

U.S. Environmental Protection Agency. Accessed June 19, 2014. Impacts on Coastal Resources. Available at <http://www.epa.gov/climatechange/impacts-adaptation/southeast.html>.

U.S. Environmental Protection Agency. 2013. Coastal zones and sea level rise.

U.S. Fish and Wildlife Service. 1970. United States List of Endangered Native Fish and Wildlife. Federal Register 35(199):16047.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1978. Listing and Protecting Loggerhead Sea Turtles as Threatened Species and Populations of Green and Olive Ridley Sea Turtles as Threatened Species or Endangered Species. Federal Register 43(146):32800-32811.

U.S. Fish and Wildlife Service. 1985. Determination of endangered and threatened status for the piping plover. Federal Register 50:50726-50734.

U.S. Fish and Wildlife Service. 1988. Recovery plan for piping plovers (*Charadrius melodus*) of the Great Lakes and Northern Great Plains. U.S. Fish and Wildlife Service, South Dakota, and Twin Cities, Minnesota.

U.S. Fish and Wildlife Service. 1994. Revised Draft - Recovery plan for piping plovers - Breeding on the Great Lakes and Northern Great Plains. U.S. Fish and Wildlife Service, Twin Cities, MN. 99 pp.

U.S. Fish and Wildlife Service. 1996a. Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp.

U.S. Fish and Wildlife Service. 1996b. Recovery plan for seabeach amaranth (*Amaranthus pumilus*). U.S. Fish and Wildlife Service, Atlanta, GA.

U.S. Fish and Wildlife Service. 2001a. Final determination of critical habitat for the Great Lakes breeding population of the piping plover. Federal Register 66:22938-22969.

U.S. Fish and Wildlife Service. 2001b. Final determination of critical habitat for wintering piping plovers. Federal Register 66:36037-36086.

U.S. Fish and Wildlife Service. 2002. Final designation of critical habitat for the Northern Great Plains breeding population of the piping plover. Federal Register. 67:57637-57717.

U.S. Fish and Wildlife Service. 2003a. Recovery plan for the Great Lakes piping plover (*Charadrius melodus*). Fish and Wildlife Service, Fort Snelling, Minnesota.

U.S. Fish and Wildlife Service. 2003b. Delaware Bay shorebird-horseshoe crab assessment report and peer review. ASMFC, Arlington, VA, Available at <http://digitalmedia.fws.gov/cdm/ref/collection/document/id/1418>.

U.S. Fish and Wildlife Service. 2003c. Seabeach Amaranth, Overview. Accessed November 5, 2010. Available at: http://www.fws.gov/northeast/nyfo/es/amaranthweb/overview.html

U.S. Fish and Wildlife Service. 2005. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas and Veracruz, Mexico 2005. Fish and Wildlife Service Technical Report.

U.S. Fish and Wildlife Service. 2009. Revised designation of critical habitat for the wintering population of the piping plover (*Charadrius melodus*) in Texas. Federal Register 74:23476-23524.

U.S. Fish and Wildlife Service. 2006. Strategic Habitat Conservation. Final Report of the National Ecological Assessment Team to the U.S. Fish and Wildlife Service and U.S. Geologic Survey.

U.S. Fish and Wildlife Service. 2007. Draft communications plan on the U.S. Fish and Wildlife Service's Role in Climate Change.

U.S. Fish and Wildlife Service. 2010. Final report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii,* on the coasts of Tamaulipas and Veracruz, Mexico.

U.S. Fish and Wildlife Service. 2012. Comprehensive Conservation Strategy for the Piping Plover in its Coastal Migration and Wintering Range in the Continental United States. East Lansing, Michigan. Available at http://www.fws.gov/midwest/EastLansing/.

U.S. Fish and Wildlife Service. 2013a. Endangered and Threatened Wildlife and Plants; Proposed Threatened Status for the Rufa Red Knot (*Calidris canutus rufa*). 78 FR 60024-60098. Docket FWS-R5-ES-2013-0097 (September 30, 2013). Available at www.regulations.gov.

U.S. Fish and Wildlife Service. 2013b. Rufa Red Knot Ecology and Abundance. Supplement to Endangered and Threatened Wildlife and Plants; Proposed Threatened Status for the Rufa Red Knot (*Calidris canutus rufa*) [FWS–R5–ES–2013–AY17].

U.S. Fish and Wildlife Service and Conserve Wildlife Foundation of New Jersey. 2012. Cooperative agreement. Project title: Identify juvenile red knot wintering areas.

U.S. Fish and Wildlife Service. Unpublished data. Seabeach amaranth rangewide data with graphs.

U.S. Global Change Research Program. 2009. Global climate change impacts in the United States. Cambridge University Press, New York, NY, Available at <http://library.globalchange.gov/2009-global-climate-change-impacts-in-the-united-states>.

Urner, C.A., and R.W. Storer. 1949. The distribution and abundance of shorebirds on the North and Central New Jersey Coast, 1928-1938. The Auk 66(2):177-194.

van Gils, J.A., P.F. Battley, T. Piersma, and R. Drent. 2005a. Reinterpretation of gizzard sizes of red knots world-wide emphasis overriding importance of prey quality at migratory stopover sites. Proceedings of the Royal Society of London, Series B 272:2609-2618.

van Gils, J.A., A. Dekinga, B. Spaans, W.K. Vahl, and T. Piersma. 2005b. Digestive bottleneck affects foraging decisions in red knots (Calidris canutus). II. Patch choice and length of working day. Journal of Animal Ecology 74:120-130.

Ward, J.R., and K.D. Lafferty. 2004. The elusive baseline of marine disease: Are diseases in ocean ecosystems increasing? PLoS Biology 2(4):542-547.

Watson, J.W., D. G. Foster, S. Epperly, and A. Shah. 2004. Experiments in the western Atlantic Northeast Distant Waters to evaluate sea turtle mitigation measures in the pelagic longline fishery. Report on experiments conducted in 2001-2003. February 4, 2004.

Weakley, A. S., and M. A. Bucher. 1992. Status survey of seabeach amaranth (Amaranthus pumilus Rafinesque) in North and South Carolina, second edition (after Hurricane Hugo). Report to North Carolina Plant Conservation Program, North Carolina Department of Agriculture, Raleigh, NC and Endangered Species Field Office, U.S. Fish and Wildlife Service, Asheville, NC.

Webster, P., G. Holland, J.Curry, and H. Chang. 2005. Changes in tropical cyclone number, duration, and intensity in a warming environment. Science Vol. 309: pp. 1844-1846.

Weishampel, J.F., D.A. Bagley, and L.M. Ehrhart. 2006. Intra-annual loggerhead and green turtle spatial nesting patterns. Southeastern Naturalist 5(3):453-462.

Westbrock, M., E.A. Roche, F.J. Cuthbert and J.H. Stucker. 2005. Piping plover breeding biology and management in the Great Lakes, 2005. Report submitted to the US Fish and Wildlife Service, East Lansing, MI.

Westbrooks, R.G., and J. Madsen. 2006. Federal regulatory weed risk assessment beach vitex (*Vitex rotundifolia* L.f.) assessment summary. USGS Biological Research Division, Whiteville, North Carolina, and Mississippi State University, GeoResources Institute. 5pp.

Wheeler, N.R. 1979. Effects of off-road vehicles on the infauna of Hatches Harbor, Cape Cod National Seashore. Unpublished report from the Environmental Institute, University of Massachusetts, Amherst, Massachusetts. UM-NPSCRU Report No. 28. [Also submitted as a M.S. Thesis entitled "Off-road vehicle (ORV) effects on representative infauna and a comparison of predator-induced mortality by *Polinices duplicatus* and ORV activity on *Mya arenaria* at Hatches Harbor, Provincetown, Massachusetts" to the University of Massachusetts, Amherst, Massachusetts.]

Wibbels, T., D.W. Owens, and D.R. Rostal. 1991. Soft plastra of adult male sea turtles: an apparent secondary sexual characteristic. Herpetological Review 22:47-49.

Wilcox, L. 1939. Notes on the life history of the piping plover. Birds of Long Island 1: 3-13.

Wilcox, L. 1959. A twenty year banding study of the piping plover. Auk 76: 129-152.

Williams, K.L., M.G. Frick, and J.B. Pfaller. 2006. First report of green, *Chelonia mydas*, and Kemp's ridley, *Lepidochelys kempii*, turtle nesting on Wassaw Island, Georgia, USA. Marine Turtle Newsletter 113:8.

Williams-Walls, N., J. O'Hara, R.M. Gallagher, D.F. Worth, B.D. Peery, and J.R. Wilcox. 1983. Spatial and temporal trends of sea turtle nesting on Hutchinson Island, Florida, 1971-1979. Bulletin of Marine Science 33(1):55-66.

Winstead, N. 2008. Letter dated 8 October 2008 from Nick Winstead, Mississippi Department of Wildlife, Fisheries and Parks, Museum of Natural Science to Patty Kelly, USFWS, Panama City, Florida Field Office regarding habitat changes in Mississippi from hurricanes and estimates of shoreline miles of mainland and barrier islands.

Witherington, B.E. 1986. Human and natural causes of marine turtle clutch and hatchling mortality and their relationship to hatching production on an important Florida nesting beach. Unpublished Master of Science thesis. University of Central Florida, Orlando, Florida.

Witherington, B. E. 1991. Orientation of hatchling loggerhead turtles at sea off artificially lighted and dark beaches. J. Exp. Mar. Biol. *Ecol.* 149, 1-11.

Witherington, B.E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48:31-39.

Witherington, B.E. 1997. The problem of photopollution for sea turtles and other nocturnal animals. Pages 303-328 *in* Clemmons, J.R. and R. Buchholz (editors). Behavioral approaches to conservation in the wild. Cambridge University Press, Cambridge, United Kingdom.

Witherington, B.E. 2006. Personal communication to Loggerhead Recovery Team on nest monitoring in Florida during 2005. Florida Fish and Wildlife Research Institute.

Witherington, B.E. and K.A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles (*Caretta caretta*). Biological Conservation 55:139-149.

Witherington, B.E., K.A. Bjorndal, and C.M. McCabe. 1990. Temporal pattern of nocturnal emergence of loggerhead turtle hatchlings from natural nests. Copeia 1990(4):1165-1168.

Witherington, B.E. and L.M. Ehrhart. 1989. Status and reproductive characteristics of green turtles (*Chelonia mydas*) nesting in Florida. Pages 351-352 *in* Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart, and R. Witham (editors). Proceedings of the Second Western Atlantic Turtle Symposium. NOAA Technical Memorandum NMFS-SEFC-226.

Witherington, B.E. and R.E. Martin. 1996. Understanding, assessing, and resolving light pollution problems on sea turtle nesting beaches. Florida Marine Research Institute Technical Report TR-2.

Witherington, B.E, L. Lucas, and C. Koeppel. 2005. Nesting sea turtles respond to the effects of ocean inlets. Pages 355-356 *in* Coyne, M.S. and R.D. Clark (compilers). Proceedings of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-528.

Witherington, B.E. and M. Salmon. 1992. Predation on loggerhead turtle hatchlings after entering the sea. Journal of Herpetology. 26(2):226-228.

Wood, D.W. and K.A. Bjorndal. 2000. Relation of temperature, moisture, salinity, and slope to nest site selection in loggerhead sea turtles. Copeia 2000(1):119-128.

Wyneken, J., Salmon, M. and K. J. Lohmann. 1990. Orientation by hatchling loggerhead sea turtles *Caretta caretta* in a wave tank. J. exp. mar. Biol. Ecol. 139, 43–50.

Wyneken, J., L. DeCarlo, L. Glenn, M. Salmon, D. Davidson, S. Weege., and L. Fisher. 1998. On the consequences of timing, location and fish for hatchlings leaving open beach hatcheries. Pages 155-156 *in* Byles, R. and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Wyneken, J. 2000. The migratory behavior of hatchling sea turtles beyond the beach. Pages 121–142 in N.J. Pilcher and G. Ismail, eds. Sea turtles of the Indo-Pacific. ASEAN Academic Press, London.

Wyneken, J., L.B. Crowder, and S. Epperly. 2005. Final report: evaluating multiple stressors in loggerhead sea turtles: developing a two-sex spatially explicit model. Final Report to the U.S. Environmental Protection Agency National Center for Environmental Research, Washington, DC. EPA Grant Number: R829094.

Zöckler, C., and I. Lysenko. 2000. Water birds on the edge: First circumpolar assessment of climate change impact on Arctic breeding water birds. World Conservation Press, Cambridge, UK, Available at <http://www.unep-wcmc.org/biodiversity-series-11_114.html>.

Zonick, C. 1997. The use of Texas barrier island washover pass habitat by piping plovers and other coastal waterbirds. National Audubon Society. A Report to the Texas Parks and Wildlife Department and the U.S. Fish and Wildlife Service. 19 pp.

Zonick, C.A. 2000. The winter ecology of the piping plover (*Charadrius melodus*) along the Texas Gulf Coast. Ph.D. dissertation. University of Missouri, Columbia, Missouri.

Zonick, C. and M. Ryan. 1996. The ecology and conservation of piping plovers (Charadrius melodus) wintering along the Texas Gulf Coast. Dept. of Fisheries and Wildlife, University of Missouri, Columbia, Missouri 65211. 1995 Annual report. 49pp.

Zug, G.R. and J.F. Parham. 1996. Age and growth in leatherback turtles, *Dermochelys coriacea* (Testidines: Dermochelyidae): a skeletochronological analysis. Chelonian Conservation and Biology 2(2):244-249.

Zurita, J.C., R. Herrera, A. Arenas, M.E. Torres, C. Calderón, L. Gómez, J.C. Alvarado, and R. Villavicencio. 2003. Nesting loggerhead and green sea turtles in Quintana Roo, Mexico. Pages 125-127 *in* Seminoff, J.A. (compiler). Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Zwarts, L., and A.M. Blomert. 1992. Why knot *Calidris canutus* take medium-sized *Macoma balthica* when six prey species are available. Marine Ecology Progress Series 83:113-128.

Appendix A

EXAMPLES OF PREDATOR PROOF TRASH RECEPTACLES

Example of predator proof trash receptacle at Gulf Islands National Seashore. Lid must be tight fitting and made of material heavy enough to stop animals such as raccoons.

Example of trash receptacle anchored into the ground so it is not easily turned over.

Example of predator proof trash receptacle at Perdido Key State Park. Metal trash can is stored inside. Cover must be tight fitting and made of material heavy enough to stop animals such as raccoons.

Example of trash receptacle must be secured or heavy enough so it is not easily turned over.

Appendix B
Parameters to be recorded for turtle crawls

CHARACTERISTIC	PARAMETER	MEASUREMENT	VARIABLE
Nesting Success	False crawls - number	Visual assessment of all false crawls	Number and location of false crawls in nourished areas and non-nourished areas: any interaction of turtles with obstructions, such as groins, seawalls, or scarps, should be noted.
	False crawl - type	Categorization of the stage at which nesting was abandoned	Number in each of the following categories: emergence-no digging, preliminary body pit, abandoned egg chamber.
	Nests	Number	The number of sea turtle nests in nourished and non-nourished areas should be noted. If possible, the location of all sea turtle nests must be marked on a project map, and approximate distance to seawalls or scarps measured in meters. Any abnormal cavity morphologies should be reported as well as whether turtle touched groins, seawalls, or scarps during nest excavation.
	Nests	Lost nests	The number of nests lost to inundation or erosion or the number with lost markers.
	Nests	Relocated nests	The number of nests relocated and a map of the relocation area(s). The number of successfully hatched eggs per relocated nest.
	Lighting impacts	Disoriented sea turtles	The number of disoriented hatchlings and adults.

Appendix C

Assessments: Discerning Problems Caused by Artificial Lighting

Excerpt from:

Understanding, Assessing, and resolving light-pollution problems on sea turtle nesting beaches
Florida Wildlife Research institute technical report tr-2
revised 2003

LIGHTING INSPECTIONS

WHAT ARE LIGHTING INSPECTIONS?

During a lighting inspection, a complete census is made of the number, types, locations, and custodians of artificial light sources that emit light visible from the beach. The goal of lighting inspections is to locate lighting problems and to identify the property owner, manager, caretaker, or tenant who can modify the lighting or turn it off.

WHICH LIGHTS CAUSE PROBLEMS?

Although the attributes that can make a light source harmful to sea turtles are complex, a simple rule has proven to be useful in identifying problem lighting under a variety of conditions:

An artificial light source is likely to cause problems for sea turtles if light from the source can be seen by an observer standing anywhere on the nesting beach.

If light can be seen by an observer on the beach, then the light is reaching the beach and can affect sea turtles. If any glowing portion of a luminaire (including the lamp, globe, or reflector) is directly visible from the beach, then this source is likely to be a problem for sea turtles. But light may also reach the beach indirectly by reflecting off buildings or trees that are visible from the beach. Bright or numerous sources, especially those directed upward, will illuminate sea mist and low clouds, creating a distinct glow visible from the beach. This "urban skyglow" is common over brightly lighted areas. Although some indirect lighting may be perceived as nonpoint-source light pollution, contributing light sources can be readily identified and include sources that are poorly directed or are directed upward. Indirect lighting can originate far from the beach.

Although most of the light that sea turtles can detect can also be seen by humans, observers should realize that some sources, particularly those emitting near-ultraviolet and violet light (e.g., bug-zapper lights, white electric-discharge lighting) will appear brighter to sea turtles than to humans. A human is also considerably taller than a hatchling; however, an observer on the dry beach who crouches to the level of a hatchling may miss some lighting that will affect turtles. Because of the way that some lights are partially hidden by the dune, a standing observer is more likely to see light that is visible to hatchlings and nesting turtles in the swash zone.

HOW SHOULD LIGHTING INSPECTIONS BE CONDUCTED?

Lighting inspections to identify problem light sources may be conducted either under the purview of a lighting ordinance or independently. In either case, goals and methods should be similar.

GATHER BACKGROUND INFORMATION

Before walking the beach in search of lighting, it is important to identify the boundaries of the area to be inspected. For inspections that are part of lighting ordinance enforcement efforts, the jurisdictional boundaries of the sponsoring local government should be determined. It will help to have a list that includes the name, owner, and address of each property within inspection area so that custodians of problem lighting can be identified. Plat maps or aerial photographs will help surveyors orient themselves on heavily developed beaches.

PRELIMINARY DAYTIME INSPECTIONS

An advantage to conducting lighting inspections during the day is that surveyors will be better able to judge their exact location than they would be able to at night. Preliminary daytime inspections are especially important on beaches that have restricted access at night. Property owners are also more likely to be available during the day than at night to discuss strategies for dealing with problem lighting at their sites.

A disadvantage to daytime inspections is that fixtures that are not directly visible from the beach will be difficult to identify as problems. Moreover, some light sources that can be seen from the beach in daylight may be kept off at night and thus present no problems. For these reasons, daytime inspections are not a substitute for nighttime inspections. Descriptions of light sources identified during daytime inspections should be detailed enough so that anyone can locate the lighting. In addition to a general description of each luminaire (e.g., HPS floodlight directed seaward at top northeast corner of the building at 123 Ocean Street), photographs or sketches of the lighting may be necessary. Descriptions should also include an assessment of how the specific lighting problem can be resolved (e.g., needs turning off; should be redirected 90° to the east). These detailed descriptions will show property owners exactly which luminaries need what remedy.

NIGHTTIME INSPECTIONS

Surveyors orienting themselves on the beach at night will benefit from notes made during daytime surveys. During nighttime lighting inspections, a surveyor walks the length of the nesting beach looking for light from artificial sources. There are two general categories of artificial lighting that observers are likely to detect:

1. Direct lighting. A luminaire is considered to be direct lighting if some glowing element of the luminaire (e.g., the globe, lamp [bulb], reflector) is visible to an observer on the beach. A source not visible from one location may be visible from another farther down the beach. When direct lighting is observed, notes should be made of the number, lamp type (discernable by color), style of fixture, mounting (pole, porch, *etc.*), and location (street address, apartment number, or pole identification number) of the luminaire(s). If exact locations of problem sources were not determined during preliminary daytime surveys, this should be done during daylight soon after the nighttime survey. Photographing light sources (using long exposure times) is often helpful.

2. Indirect lighting. A luminaire is considered to be indirect lighting if it is not visible from the beach but illuminates an object (e.g., building, wall, tree) that is visible from the beach. Any object on the dune that appears to glow is probably being lighted by an indirect source. When possible, notes should be made of the number, lamp type, fixture style, and mounting of an indirect-lighting source. Minimally, notes should be taken that would allow a surveyor to find the lighting during a follow-up daytime inspection (for instance, which building wall is illuminated and from what angle?).

WHEN SHOULD LIGHTING INSPECTIONS BE CONDUCTED?

Because problem lighting will be most visible on the darkest nights, lighting inspections are ideally conducted when there is no moon visible. Except for a few nights near the time of the full moon, each night of the month has periods when there is no moon visible. Early-evening lighting inspections (probably the time of night most convenient for inspectors) are best conducted during the period of two to 14 days following the full moon. Although most lighting problems will be visible on moonlit nights, some problems, especially those involving indirect lighting, will be difficult to detect on bright nights.

A set of daytime and nighttime lighting inspections before the nesting season and a minimum of three additional nighttime inspections during the nesting-hatching season are recommended. The first set of day and night inspections should take place just before nesting begins. The hope is that managers, tenants, and owners made aware of lighting problems will alter or replace lights before they can affect sea turtles. A follow-up nighttime lighting inspection should be made approximately two weeks after the first inspection so that remaining problems can be identified. During the nesting-hatching season, lighting problems that seemed to have been remedied may reappear because owners have been forgetful or because ownership has changed. For this reason, two midseason lighting inspections are recommended. The first of these should take place approximately two months after the beginning of the nesting season, which is about when hatchlings begin to emerge from nests. To verify that lighting problems have been resolved, another follow-up inspection should be conducted approximately one week after the first midseason inspection.

WHO SHOULD CONDUCT LIGHTING INSPECTIONS?

Although no specific authority is required to conduct lighting inspections, property managers, tenants, and owners are more likely to be receptive if the individual making recommendations represent a recognized conservation group, research consultant, or government agency. When local ordinances regulate beach lighting, local government code-enforcement agents should conduct lighting inspections and contact the public about resolving problems.

WHAT SHOULD BE DONE WITH INFORMATION FROM LIGHTING INSPECTIONS?

Although lighting surveys serve as a way for conservationists to assess the extent of lighting problems on a particular nesting beach, the principal goal of those conducting lighting inspections should be to ensure that lighting problems are resolved. To resolve lighting problems, property managers, tenants, and owners should be give the information they need to make proper alterations to light sources. This information should include details on the location and description of problem lights, as well as on how the lighting problem can be solved. One should also be prepared to discuss the details of how lighting affects sea turtles. Understanding the nature of the problem will motivate people more than simply being told what to do.

Lighting Survey Form for NC

Lighting survey must be conducted to include a landward view from the seaward most extent of the beach profile. Survey must occur after 9pm. The survey shall follow standard techniques for such a survey and include the number and type of visible lights, location of lights and photo documentation.

Date: ______________________________

Location (name of beach): ________________________

Contact information of person conducting the lighting survey: ___________________

____

Time survey started: _____

Time survey ended: _____

Location survey began (include address or GPS location):________________________

____

Location survey ended (include address or GPS location): _______________________

____

Date summarizing report sent to the following:
seaturtle@fws.gov:________________________

Contact information for follow up meeting with the FWS and State Wildlife Agency:
____

For each light visible from the nesting beach provide the following information:

Location of Light (include cross street and nearest beach access)	GPS location of Light	Description of light (type and location)	Photo take (YES/ NO)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

F/SER31:KBD

MAR 0 3 2016

Scott C. McLendon
Chief, Regulatory Division
Wilmington District Corps of Engineers
Department of the Army
69 Darlington Avenue
Wilmington, North Carolina 28403-1343

Dear Mr. McLendon:

This letter responds to your request for consultation with us, the National Marine Fisheries Service (NMFS), pursuant to Section 7 of the Endangered Species Act (ESA) for the following action.

Permit Number	Applicant	SER Number	Project Type
SAW-2011-01241	Town of Ocean Isle Beach	SER-2015-16308	Terminal groin construction and beach nourishment

Consultation History
We received your letter requesting consultation on January 29, 2015. It was assigned to a Consultation Biologist on April 21, 2015. We initiated consultation on June 12, 2015, but due to a large workload, we were not able to proceed with completion of our letter until several months later.

Project Location

Address	Latitude/Longitude	Water body
Ocean Isle Beach, Brunswick County, North Carolina	33.898881°N, 78.389769°W (North American Datum 1983)	Shallotte Inlet, Atlantic Ocean

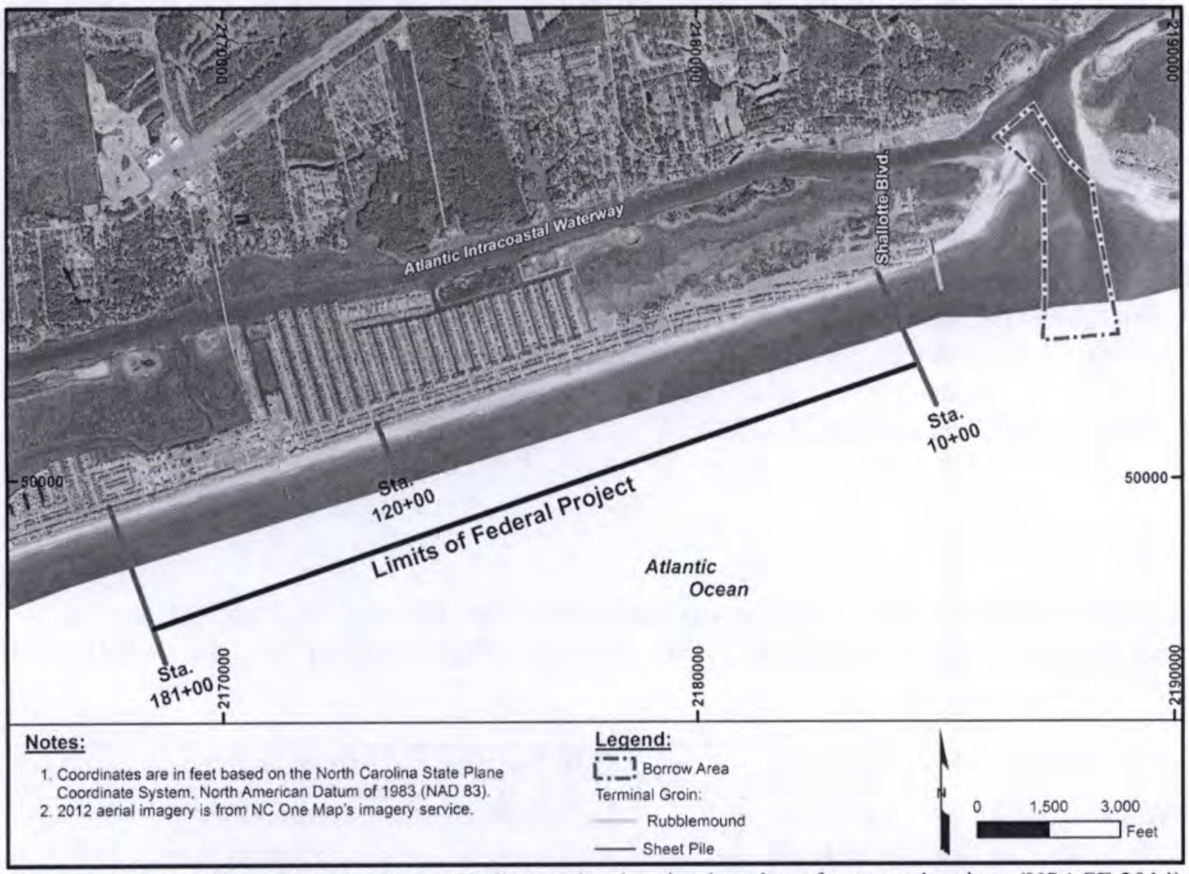


Figure 1. Town of Ocean Isle Beach and Shallotte Inlet showing location of proposed actions (USACE 2014)

Existing Site Conditions

The project area includes the beach at the Town of Ocean Isle Beach along Shallotte Boulevard and the borrow area within Shallotte Inlet located to the east. The purpose of the proposed project is to alleviate chronic erosion on the eastern portion of Ocean Isle Beach to preserve the integrity of its infrastructure, provide protection to existing development, and ensure the continued use of the oceanfront beach along the easternmost 3,500 feet (ft) of its oceanfront shoreline. Several beachfront properties and road infrastructures have been lost to erosion during the past few years. Many more properties and sections of road are in danger of being lost unless the beach can be restored soon. Sediments in the project area generally consist of sands, silts, and clays occurring in various mixtures. No seagrasses or corals are present.

Project Description

The project includes the construction of a terminal groin perpendicular to the shore of the east end of Ocean Isle Beach and placement of sand along 3,214 ft of shoreline adjacent to the Atlantic Ocean in Brunswick County, North Carolina. The nourishment sand would be excavated from maintenance of the existing borrow site in Shallotte Inlet that has previously been used for the federal storm damage reduction project. A cutterhead dredge will be used. The project is designed to control tidal current-induced shoreline changes immediately west of Shallotte Inlet. The terminal groin would include a 300-ft shore anchorage section extending landward from the 2007 mean high water (MHW) shoreline and a rubblemound section extending 750 ft seaward of the 2007 MHW. The shore anchorage section would be constructed with either steel or concrete sheet pile. The rubblemound portion of the terminal groin would be constructed with loosely placed armor stone on top of a foundation mat or mattress and would have a crest elevation of +4.9 ft NAVD. The armor stone would facilitate the movement of littoral material through the structure while the relative low crest elevation would allow some sediment to pass over the structure during periods of high tide. The terminal groin would slope 1H:3V from the structure crest down to the existing ocean floor. The rubblemound portion of the terminal groin would be constructed from a temporary trestle or pier installed parallel to the alignment of the terminal groin. The trestle would be removed upon completion of the construction of the terminal groin. Approximately 14,300 tons of stone would be required to construct the terminal groin. Materials for the nourishment and rock rubble for the groin construction will be transported by barge to a dock in the intracoastal waterway at the north end of Shallotte Boulevard. From there, the material would be off-loaded to trucks and transported to the beach construction site. Stone rubble would consist of 7.5 to 12-ton stones, approximately 5 ft in diameter. A 50 ft construction buffer will be in place around the construction zone. The proposed start date of the dredging of Shallotte Inlet and the beach nourishment is November 15 with the project to be completed by April 30. Groin construction and placement of sand is expected to take up to 4.5 months. Maintenance of the nourishment area is expected to occur on 5-year intervals and would take approximately 10 weeks to accomplish.

Effects Determinations for Species the USACE or NMFS Believes May Be Affected by the Proposed Action

Species	ESA Listing Status	Action Agency Effect Determination	NMFS Effect Determination
Sea Turtles			
Green	E/T[1]	NLAA	NLAA
Kemp's ridley	E	NLAA	NLAA
Leatherback	E	NLAA	NE
Loggerhead (Northwest Atlantic Ocean distinct population segment [DPS])	T	NLAA	NLAA
Hawksbill	E	NLAA	NE
Fish			
Shortnose sturgeon	E	NLAA	NLAA
Atlantic sturgeon (Carolina DPS)	E	NLAA	NLAA
Whales			
North Atlantic right	E	NLAA	NP
Humpback	E	NLAA	NP
Finback	E	NLAA	NP
Sei	E	NLAA	NP
Sperm	E	NLAA	NP

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

Species	ESA Listing Status	Action Agency Effect Determination	NMFS Effect Determination
E = endangered; T = threatened; NLAA = may affect, not likely to adversely affect; NP = not present; NE = no effect			

We believe the project will have no effect on hawksbill and leatherback sea turtles, due to the species' very specific life history strategies, which are not supported at the project site. Leatherback sea turtles have pelagic, deepwater life history, where they forage primarily on jellyfish. Hawksbill sea turtles typically inhabit inshore reef and hard bottom areas where they forage primarily on encrusting sponges. There have been no reports of hawksbill or leatherback sea turtles nesting in the project area. We also do not believe that whales would be found in the nearshore project area where the terminal groin will be constructed or where the shallow inlet will be dredged. In addition, NMFS has previously determined that potential effects on North Atlantic right whales, and finback, sperm, sei, and humpback whales from dredging are discountable and will not be addressed further (Re: SER-2012-00948).

Critical Habitat
The project is located within the boundary of Northwest Atlantic loggerhead sea turtle distinct population segment (NWA DPS) LOGG-N-5.

Analysis of Potential Routes of Effects to Listed Species and Critical Habitat
Three species of sea turtles (loggerhead, green, and Kemp's ridley) and 2 species of sturgeon (shortnose and Atlantic) may be found in or near the action area and may be affected by the project. We have identified the following potential adverse effects to these listed species and concluded they are not likely to be adversely affected by the proposed action for the reasons described below.

<u>Sea Turtles</u>
Loggerhead, green, and Kemp's ridley sea turtles are known to nest on the beaches of North Carolina and have been sited near the project area, but only the loggerhead sea turtle has been reported nesting near the project site on Ocean Isle Beach. Sea turtles may be injured if they encounter the cutterhead dredging in the borrow area. However, we believe this adverse effect is discountable because these species are likely to move away from the dredging equipment and we expect them to exhibit avoidance behavior. NMFS has previously determined in existing biological opinions (i.e., the South Atlantic Regional Biological Opinion and the Gulf of Mexico Regional Biological Opinion) that non-hopper-type dredging activities, including hydraulic and mechanical-type dredges (including cutterhead and clamshell dredges), are not likely to adversely affect sea turtles, primarily because they are noisy and slow moving, enabling sea turtles to detect and avoid them, or affect only very small areas at one time. The implementation of the proposed dredging window and timing of the beach nourishment (November 15 to April 30) to avoid the presence of sea turtles will further reduce the risk of encounters and will not occur during nesting season, which begins May 1. In addition, operation of any mechanical construction equipment will cease immediately if a sea turtle is seen within a 50-ft radius of the equipment. Activities will not resume until the protected species has departed the project area of its own volition. Nourishment sand will be transported to the project site via trucks. Because

hopper dredges will not be used, the movements of the cutterhead dredge will be limited to the spatially constrained nearshore borrow area, a dredging window will be implemented, and sand placement on the beach will be via truck-hauled sand, we believe the potential for encounters with sea turtles is discountable or not likely to occur.

The construction of the terminal groin will occur concurrent with the nourishment activities and the act of placing material within open water may adversely affect sea turtles; however, construction will be spatially confined and temporary. We believe that sea turtles will be able to avoid the construction area around the terminal groin. In addition, the project area occurs within a segment of North Carolina's shoreline that is experiencing severe erosion with historically low numbers of nest sites relative to other areas with more stable beach areas. Since the existing condition of the project area is not conducive to sea turtles laying nests and the proposed action is restorative in nature, NMFS believes that the post-construction access to restored portions of the beach should benefit sea turtles, specifically in re-creating beach nesting habitat and therefore we believe that the likelihood of sea turtles being affected by the proposed groin construction is insignificant.

Critical Habitat for Loggerhead NWA DPS
The proposed dredging and groin construction will occur within critical nearshore reproductive habitat for the loggerhead sea turtle (LOGG-N-5), which extends one mile from MHW. Nearshore reproductive habitat includes habitat for the hatchling swim frenzy and for females during the internesting period from the shoreline (MHW seaward 1 mile). This nearshore zone is a vulnerable, pivotal transitional habitat area for hatchling transit to open waters, and for nesting females to transit back and forth between open waters and nesting beaches during their multiple nesting attempts throughout the nesting season. The habitat characteristics of this nearshore zone are important in female nest site selection and successful repeat nesting. In addition to nesting beach suitability and proximity to nearshore oceanic currents needed for hatchling transport, habitat suitable for transit between the beach and open waters by the adult female turtle is necessary. Nesting females typically favor beach approaches with few obstructions or physical impediments such as reefs or shallow water rocks, which may make the entrance to nearshore waters more difficult or even injure the female as she attempts to reach the surf zone.

The three physical and biological features essential to loggerhead conservation in this critical habitat unit and their current condition in the project area are described below. The first essential component to conservation is nearshore waters directly off the highest density nesting beaches as identified in 78 FR 18000 (March 25, 2013) to 1 mile offshore. The project area beach is currently severely eroded and has a history of being an erosional hot spot. It is also not located near the highest density nesting beaches, so this action would not affect the nearshore waters in that area; therefore there is no effect to the essential feature. The second essential feature to promote loggerhead survival is waters that are sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water. The dredging would be taking place within Shallotte Inlet and not in the surf zone or in open water in front of nesting beaches, so there would be no obstructions to the open water from dredging. The terminal groin would be constructed perpendicular to the beach and would not present obstruction toward open waters. The third is waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents. The construction of the terminal groin could impact sea turtle critical habitat. Yet, the proposed groin is designed as a low-crested, semi-permeable (i.e., "leaky") structure designed to permit seawater and animals to flow over the top and through the structure. It also will allow the longshore transport of sand to occur in a normal manner, so it should not disrupt wave patterns or create excessive longshore currents. It is possible that the groin could cause some predator concentration, but the majority of the rocks comprising the groin will be submerged too deep to accommodate resting seabirds that could prey on hatchlings. NMFS believes that the addition of the terminal groin will improve the condition of the nesting beach overall, and it will not cause a net increase in the likelihood of predator concentration, or cause wave patterns to be modified to the extent that it will disrupt orientation nor cause excessive longshore currents. Beach widening due to sand entrapment behind the terminal groin will result in increasing the amount of available turtle nesting habitat. Once the beach is stabilized and restored, we expect that nesting activity may increase in the project area. For these reasons, NMFS concludes that the effects of the proposed action on loggerhead sea turtle critical habitat are insignificant.

Sturgeon

Shortnose sturgeon were thought to be extirpated from North Carolina waters until an individual was captured in the Brunswick River in 1987. Subsequent gillnet studies (1989-1993) resulted in the capture of 5 shortnose sturgeon, confirming the presence of a small population in the lower Cape Fear River. Based on its restriction primarily to the portions of rivers above the freshwater-saltwater interface, its occurrence within the project area (i.e., Shallotte Inlet and within the Atlantic Ocean) is considered extremely unlikely; therefore, likely effects to this species are discountable or not likely to occur.

We believe that Atlantic sturgeon may be affected by the dredging in Shallotte Inlet. Atlantic sturgeon may be encountered as they pass through the Shallotte Inlet while leaving or returning to the nearshore ocean waters or while accessing upriver spawning and nursery areas from mid-winter to mid-spring. Adults spend the majority of their lives migrating up and down the coast in nearshore marine waters, only returning to their natal rivers to spawn. Atlantic sturgeon found in the project area are most likely a part of the Carolina DPS. The Carolina DPS includes all Atlantic sturgeon that are spawned in the watersheds (including all rivers and tributaries) from the Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor. Rivers known to have current spawning populations within the range of the Carolina DPS include the Roanoke, Tar-Pamlico, Cape Fear, Waccamaw, and Yadkin-Pee Dee River. Dredging can impact important habitat features of Atlantic sturgeon as they disturb benthic fauna and alter bottom habitat; however dredging will be conducted in an area that is highly dynamic and receives constant disturbance of bottom habitat from storm events and strong currents. Because the nearshore areas around Shallotte Inlet offers an abundance of habitat that will not be affected by the project and is probably more suitable for foraging or resting, we believe the dredging effects associated with the project will be insignificant. Although dredges have been known to impact sturgeon, the proposed dredging is to be performed with a slow-moving cutterhead dredge. NMFS believes that the impacts of this project are minimal given the mobility of the species and its ability to avoid encounters with the dredge. We have also identified the following potential route of effects from physical impacts from in-water construction of the terminal groin to sturgeon and concluded they are not likely to be adversely affected by the proposed action. Since sturgeon are highly mobile, they can avoid the area of disturbance. Furthermore, the construction equipment will be near-stationary as it will be a very slow process of adding rock materials to form the groin. Therefore, we have determined that the potential impacts associated with the proposed dredging and construction of the terminal groin will be insignificant.

Conclusion
Because all potential project effects to listed species and critical habitat were found to be discountable, insignificant, or beneficial we conclude that the proposed action is not likely to adversely affect listed species under NMFS's purview. This concludes your consultation responsibilities under the ESA for species under NMFS's purview. Consultation must be reinitiated if a take occurs or new information reveals effects of the action not previously considered, or if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat in a manner or to an extent not previously considered, or if a new species is listed or critical habitat designated that may be affected by the identified action. NMFS's findings on the project's potential effects are based on the project description in this response. Any changes to the proposed action may negate the findings of this consultation and may require reinitiation of consultation with NMFS.

We have enclosed additional relevant information for your review. We look forward to further cooperation with you on other projects to ensure the conservation of our threatened and endangered marine species and designated critical habitat. If you have any questions on this consultation, please contact Kay Davy, Consultation Biologist, at (727) 415-9271, or by e-mail at kay.davy@noaa.gov.

Sincerely,

Roy E. Crabtree, Ph.D.
for Regional Administrator

Enc.: 1. *Sea Turtle and Smalltooth Sawfish Construction Conditions* (Revised March 23, 2006)
2. *PCTS Access and Additional Considerations for ESA Section 7 Consultations* (Revised March 10, 2015)

File: 1514-22.F.1

SEA TURTLE AND SMALLTOOTH SAWFISH CONSTRUCTION CONDITIONS

The permittee shall comply with the following protected species construction conditions:

a. The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.

b. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

c. Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

d. All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

e. If a sea turtle or smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

f. Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

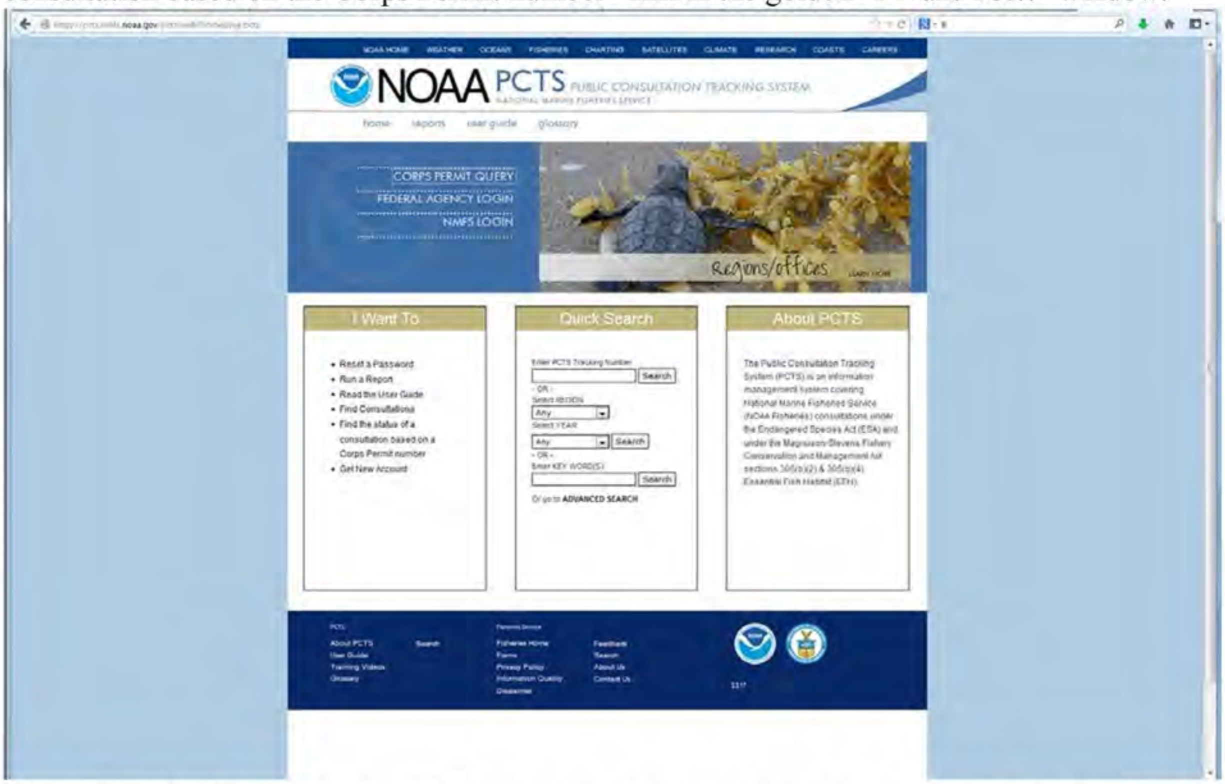
g. Any special construction conditions, required of your specific project, outside these general conditions, if applicable, will be addressed in the primary consultation.

Revised: March 23, 2006

PCTS Access and Additional Considerations for ESA Section 7 Consultations (Revised 03-10-2015)

Public Consultation Tracking System (PCTS) Guidance: PCTS is a Web-based query system at **https://pcts.nmfs.noaa.gov/** that allows all federal agencies (e.g., U.S. Army Corps of Engineers - USACE), project managers, permit applicants, consultants, and the general public to find the current status of NMFS's Endangered Species Act (ESA) and Essential Fish Habitat (EFH) consultations which are being conducted (or have been completed) pursuant to ESA Section 7 and the Magnuson-Stevens Fishery Conservation and Management Act's (MSA) Sections 305(b)2 and 305(b)(4). Basic information including access to documents is available to all.

The PCTS Home Page is shown below. For USACE-permitted projects, the easiest and quickest way to look up a project's status, or review completed ESA/EFH consultations, is to click on either the "Corps Permit Query" link (top left); or, below it, click the "Find the status of a consultation based on the Corps Permit number" link in the golden "I Want To…" window.



Then, from the "Corps District Office" list pick the appropriate USACE district. In the "Corps Permit #" box, type in the 9-digit USACE permit number identifier, with no hyphens or letters. Simply enter the year and the permit number, joined together, using preceding zeros if necessary after the year to obtain the necessary 9-digit (no more, no less) number. For example, the USACE Jacksonville District's issued permit number SAJ-2013-0235 (LP-CMW) must be typed in as 201300235 for PCTS to run a proper search and provide complete and accurate results. For querying permit applications submitted for ESA/EFH consultation by other USACE districts, the procedure is the same. For example, an inquiry on Mobile District's permit MVN201301412 is entered as 201301412 after selecting the Mobile District from the "Corps District Office" list. PCTS questions should be directed to Kelly Shotts at Kelly.Shotts@noaa.gov or (727) 551-5603.

EFH Recommendations: In addition to its protected species/critical habitat consultation requirements with NMFS' Protected Resources Division pursuant to Section 7 of the ESA, prior to proceeding with the proposed action the action agency must also consult with NMFS' Habitat Conservation Division (HCD) pursuant to the MSA requirements for EFH consultation (16 U.S.C. 1855 (b)(2) and 50 CFR 600.905-.930, subpart K). The action agency should also ensure that the applicant understands the ESA and EFH processes; that ESA and EFH consultations are separate, distinct, and guided by different statutes, goals, and time lines for responding to the action agency; and that the action agency will (and the applicant may) receive separate consultation correspondence on NMFS letterhead from HCD regarding their concerns and/or finalizing EFH consultation.

Marine Mammal Protection Act (MMPA) Recommendations: The ESA Section 7 process does not authorize incidental takes of listed or non-listed marine mammals. If such takes may occur an incidental take authorization under MMPA Section 101 (a)(5) is necessary. Please contact NMFS' Permits, Conservation, and Education Division at (301) 713-2322 for more information regarding MMPA permitting procedures.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

May 31, 2016 F/SER47:KR/pw

(Sent via Electronic Mail)

Colonel Kevin P. Landers Sr., Commander
U.S. Army Corps of Engineers Wilmington District
69 Darlington Avenue
Wilmington, North Carolina 28403-1398

Attention: Tyler Crumbley

Dear Colonel Landers:

NOAA's National Marine Fisheries Service (NMFS) has reviewed the *Final Environmental Impact Statement, Ocean Isle Beach Shoreline Management Project, Town of Ocean Isle Beach, North Carolina* (FEIS), dated April 15, 2016, and the corresponding public notice for Action ID No. SAW-2011-01241, dated April 29, 2016. The NMFS has also reviewed the separate *Essential Fish Habitat (EFH) Assessment* for the *Ocean Isle Beach Shoreline Management Project*, dated January 2015. The Town of Ocean Isle Beach proposes to provide hurricane protection, storm damage reduction, and beach erosion control along the eastern portion of the island adjacent to Shallotte Inlet in Brunswick County by constructing a terminal groin, filling and re-contouring the shoreline west of the terminal groin, and nourishing the beach at five-year intervals over a 30-year period. The Wilmington District's initial determination is the proposed project may adversely affect essential fish habitat (EFH) or associated fisheries managed by South Atlantic Fishery Management Council (SAFMC), the Mid-Atlantic Fishery Management Council, or NMFS. As the nation's federal trustee for the conservation and management of marine, estuarine, and diadromous fishery resources, the NMFS provides the following comments pursuant to authorities of the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act).

Description of the Proposed Project

After consideration of the costs, benefits, and environmental impacts of the proposed project and alternative actions, the Town of Ocean Isle Beach proposes to construct a 750-foot terminal groin with a 300-foot anchorage system extending landward to stabilize the groin. The groin would be designed to allow littoral transport of sand over, around, and through the structure by leaving large voids between the rocks. The groin design would allow for some longshore transport of water and larval fish. The project also includes nourishing a 3,214-foot section of shoreline west of the terminal groin. The shoreline would be contoured and filled with 264,000 cubic yards of sand meeting state and federal standards for beach compatibility. The sand would be sourced from Shallotte Inlet, and the nourished shoreline section would have a five-year maintenance schedule. To minimize impacts to living marine resources, construction activities for the groin and placement of sand would occur during November 16 to April 30. Due to staffing limitations, the NMFS was not able to comment on the project's Draft Environmental

Impact Statement; however, the NMFS participated in scoping and planning meetings, especially those evaluating the project alternatives discussed in the FEIS.

Comments of Final Environmental Impact Statement and EFH Assessment
Pursuant to the Magnuson-Stevens Act, the SAFMC designates EFH within the study area to encompass intertidal flats, high salinity surf zones, and tidal inlets (including their ebb and flood shoal complexes). Chapter 4 of the FEIS and Section 3.1 of the EFH Assessment describe the environmental setting of the project, including detailed descriptions of EFH and affected fishery resources.

The FEIS and EFH Assessment both review anticipated environmental impacts within the proposed 4,411-acre project area. The authors describe with depth, detail, and scientific support the direct and indirect effects expected to occur within the diverse estuarine and coastal habitats of the project area. Further, the authors provide detailed reviews of the EFH for managed species occurring within the project area and habitats designated by the State of North Carolina as Primary Nursery Area. An EFH effects determination is provided for each habitat type and for each managed fishery species.

Generalized environmental impacts are expected to be temporary in nature and of short duration (days) following construction and maintenance activities. Impacts from dredging and nourishment activities include an increase in the turbidity and total suspended solids from sediments, silt, and organic materials. High concentrations of suspended solids for extended durations can impair biological productivity and ecological function by clogging fish gills, affecting recruitment of fish and invertebrates (crustaceans and invertebrates), and suppressing growth of SAV and shellfish (e.g., oysters, clams, scallops). Activities such as beach nourishment typically have more severe impacts that take longer periods of time (months and years) for ecological recovery. Ocean beach and estuarine shorelines can be dynamic and resilient ecosystems. These ecosystems are often able to recover quickly despite experiencing extreme disturbance events from storms and hurricanes. Nourishment activities that bury infaunal communities results in direct mortality of many forage species. These infaunal species provide important trophic linkages coupling benthic-pelagic ecosystems. Many of the organisms utilizing these habitats also provide trophic linkages between inshore and offshore populations.

The primary concern the NMFS has with the proposed project is the cumulative effect from frequent mining of the inlet when considered with the frequency of inlet dredging utilized in navigation projects and other shoreline protection projects in the region. Secondarily, the NMFS is concerned about the impacts of beach nourishment on infaunal prey resources and foraging habitat provided by the beach shoreline complex.

To address these concerns, the FEIS and EFH Assessment describe a work moratorium for April 1 through November 15 to minimize environmental impacts and provide protections for seasonal migrations of fish and protected species (i.e., sturgeon, sea turtles). The NMFS appreciates the EFH Assessment recognizing inlets serve as migratory corridors for larvae entering nursery areas and for sub-adults leaving nursery areas for maturation and spawning offshore. The results of models and literature suggest mortality associated with larval entrainment by the dredge would be minimal and localized when appropriate precautions are taken. The FEIS and EFH

Assessment also describe how project monitoring would integrate with the monitoring requirements of the North Carolina Shoreline Management Plan, which includes measures to remove the terminal groin if adverse impacts cannot be mitigated. The NMFS believes inclusion of the monitoring, habitat mapping, sediment transport modeling, and shoreline modeling significantly improved the FEIS and provide an adaptive management framework for avoiding and minimizing impacts to EFH.

Based on the information provided, the NMFS has no EFH conservation recommendations for the project. The NMFS may provide EFH conservation recommendations in the future based on new information or changes in the project design that show adverse impacts would occur to EFH or federally-managed fishery species.

Thank you for the opportunity to provide these comments on the FEIS and EFH Assessment, and the NMFS looks forward to further cooperation with this project that is so important for North Carolina. Please direct related questions or comments to the attention of Dr. Ken Riley at our Beaufort Field Office, 101 Pivers Island Road, Beaufort, North Carolina 28516-9722, or at (252) 728-8750.

Sincerely,

Pace Wilber

/ for

Virginia M. Fay
Assistant Regional Administrator
Habitat Conservation Division

cc: COE, Tyler.Crumbley@usace.army.mil
USFWS, Pete_Benjamin@usfws.gov
NCDCM, Doug.Huggett@ncmail.net
NCDCM, Gregg.Bodnar@ncdenr.gov
EPA, Bowers.Todd@epa.gov
SAFMC, Roger.Pugliese@safmc.net
F/SER4, David.Dale@noaa.gov
F/SER47, Ken.Riley@noaa.gov

Appendix G

Inlet Management Plan

Ocean Isle Beach Shoreline and Inlet Management Plan

Introduction

The legislation passed by the NC General Assembly in June 2011 authorizing the permitting of terminal groins at four (4) inlets in North Carolina carried with it the requirement to provide a plan for managing inlet and the estuarine and ocean shorelines likely to be under the influence of the inlet. During the 2013 legislative session, the General Assembly adopted Session Law 2013-384 (Senate Bill 151) that modified some of the requirements that have to be met in order to permit a terminal groin. Most notably, the 2013 legislation no longer requires the applicant to demonstrate structures and infrastructure are "imminently threatened only that they are "threatened" by erosion. The 2013 legislation still requires the applicant to implement an inlet management plan that includes the following:

(1) A monitoring plan.
(2) A baseline for assessing adverse impacts and thresholds for when adverse impact must be mitigated.
(3) A description of mitigation measures to address adverse impacts.
(4) A plan to modify or remove the terminal groin if adverse impacts cannot be mitigated.

As stated in the legislation:

"The inlet management plan monitoring and mitigation requirements must be reasonable and not impose requirements whose costs outweigh the benefits. The inlet management plan is not required to address sea level rise."

The USACE established a comprehensive inlet and shoreline management plan in December 2002 for the Federal storm damage reduction project (USACE, 2002). The various aspects of that plan, which are described below, are adopted for the Ocean Isle Beach preferred shoreline management project involving a terminal groin and beach fill along the eastern end of the island (Alternative 5). In addition to the USACE monitoring program, which would serve to satisfy items (1) and (2) of the mandated management plan listed above, measures to mitigate project related adverse impacts as well as plans to modify or remove the terminal groin if adverse impacts cannot be mitigate are discussed in the following sections.

(1) Monitoring Plan. The expressed purpose of the USACE monitoring program is to:

1) Monitor the Ocean Isle Beach and Holden Beach shorelines adjacent to Shallotte Inlet to verify the anticipated response of the inlet shoulders and ebb-tide shoal to dredging of the inlet as a borrow area.
2) Provide data to track the performance of the beach fill placement in order to plan and schedule the periodic renourishment of the Federal project.

3) Monitor the performance of Shallotte Inlet as a borrow area and sediment trap in order to plan dredging for the periodic renourishment.

The scope of the USACE monitoring program, detailed below, would be sufficient to track impacts of the terminal groin on the shoreline of Ocean Isle Beach east and west of the terminal groin, evaluate structure induced changes in the behavior of the inlet shoulders, and determine if the structure is negatively impacting shoreline behavior on the west end of Holden Beach.

With the federal storm damage reduction project having been completed in 2001 followed by subsequent periodic nourishment events in 2006-07, 2010, and 2014, all of which used the borrow area in Shallotte Inlet, the impacts of the federal project following the implementation of the terminal groin project would continue. Therefore, in order to assess incremental impacts of the terminal groin on the adjacent shorelines as well as the environs around Shallotte Inlet, post-terminal groin changes in these areas would need to be compared with changes that were occurring during the time in which only the federal project was active.

The evaluation of habitat changes in the vicinity of Shallotte Inlet will be accomplished through analysis of aerial photographs that are included as part of the routine monitoring program. These same aerial photographs will be used to monitoring shoreline changes along the AIWW east and west of Shallotte Inlet. The shoreline change analysis will include the AIWW shoreline west to Shallotte Boulevard on the Ocean Isle side and east to the mouth of the Shallotte River including Monks Island situated immediately behind the west end of Holden Beach.

Monitoring Program. The USACE monitoring program, which again is adopted for the preferred terminal groin alternative for erosion protection along the east end Ocean Isle Beach, includes beach profile surveys covering 27,000 feet of shoreline on Ocean Isle Beach and 10,000 feet of shoreline on the west end of Holden Beach (Figure 6.2), radial profiles around the east and west shoulders of Shallotte Inlet (Figure 6.3), hydrographic survey of the inlet, and aerial photos. The beach profiles, which are spaced at 500-foot intervals, are surveyed every six months (fall and spring) while the inlet radial profiles are to be taken each spring. The aerial photos are also taken in the spring. To date, the USACE has published two monitoring reports, the first in December 2002 (USACE, 2002) and the second in June 2005 (USACE, 2005). While subsequent monitoring reports have not been published, the USACE has continued to collect monitoring data along the east end of the federal project and the west end of Holden Beach and has used the data to design the 2010 and 2014 periodic nourishment operations. Some of the same monitoring data was used in the evaluation of the various shoreline and inlet management alternatives included in this document.

However, beginning in 2010, budget shortfalls resulted in the USACE modifying the survey coverage with most surveys limited to the area on Ocean Isle Beach that fall within the limits of the federal project. In order to continue survey coverage for the entire town, the Town of Ocean Isle Beach initiated a beach profile monitoring program that includes areas on the east and west ends of the island that have not been surveyed by the USACE since about 2010. The east end surveys include the radial profiles around the east shoulder of Shallotte Inlet starting at station -30+00 and extending west along the beach to baseline station 20+00. The west end coverage starts at baseline station 170+00 and extends west to baseline station 275+00.

The numerical modeling of the terminal groin alternative indicated there would not be any shoreline impact, either positive or negative, west of station 30+00 on Ocean Isle Beach or on the west end of Holden Beach, therefore, the USACE monitoring program is more than sufficient to satisfy the legislative requirements.

<u>(2) Shoreline Change Thresholds</u>. As part of the monitoring plan, the USACE developed shoreline change thresholds for Ocean Isle Beach and Holden Beach using shoreline change data developed by the NC Division of Coastal Management (NCDCM) for the time period 1938 to 1992 supplemented by a March 2001 pre-construction shoreline interpreted from aerial photographs (USACE, 2002). The USACE used least square analysis to establish shoreline trends at each 50-meter transect included in the NCDCM data set and to establish 95% confidence limits around the computed shoreline change trends. Next, the USACE matched the NCDCM transects to the beach profile monitoring profiles shown in Figure 6.1 and computed average shoreline change rates and average 95% confidence intervals for each profile. With the monitoring profiles spaced every 500 feet and the NCDCM transects every 50 meters, the averages were based on NCDCM transects on each side of the profile station. In general, the average shoreline change rates and confidence intervals applicable to each 500-foot profile station represent the average of 7 NCDCM transects.

In establishing the shoreline change thresholds, the USACE excluded areas on the west end of Holden Beach and the east end of Ocean Isle Beach that are included in the area presently designated as an Inlet Hazard Area. The USACE found shoreline changes within the Inlet Hazard Area to be too erratic to establish long-term trends. The excluded areas are shown in Figure 6.4.

The shoreline change rates, 95% confidence intervals, and the shoreline change threshold adopted by the USACE for each profile station on Ocean Isle Beach and Holden Beach are provided in Table 6.1. The shoreline change rate threshold adopted by the USACE was computed by subtracting one-half of the 95% confidence interval from the average shoreline change rate at each profile. For the area on the west end of Holden Beach between profile stations 375 and 400, the overall change in the shoreline was accretion, however; the USACE could not establish definitive shoreline change trends due to the unpredictable influence of the Shallotte Inlet bar channel on the shoreline. For this area the USACE adopted a threshold rate of 0 feet/year applicable to profiles 375 to 400.

While the past behavior of the west end of Holden Beach has been somewhat erratic, particularly since completion of initial construction of the federal storm damage reduction project on Ocean

Isle Beach, the shoreline change thresholds for the west end of Holden Beach used by the USACE were modified for the terminal groin project by applying the same protocol between stations 375 and 400 as used to establish thresholds for the other transects. Adopting this protocol results in positive, i.e., accretionary, shoreline change thresholds between stations 375 and 400 rather than 0 feet/year adopted by the USACE. These revised shoreline change threshold values for the extreme west end of Holden Beach are provided in Table 6.1.

The use of 95% confidence intervals in establishing shoreline change rate thresholds provides a degree of certainty that observed shoreline change rates that exceed the threshold values are indicative of changes that would not have been expected to occur under pre-project conditions.

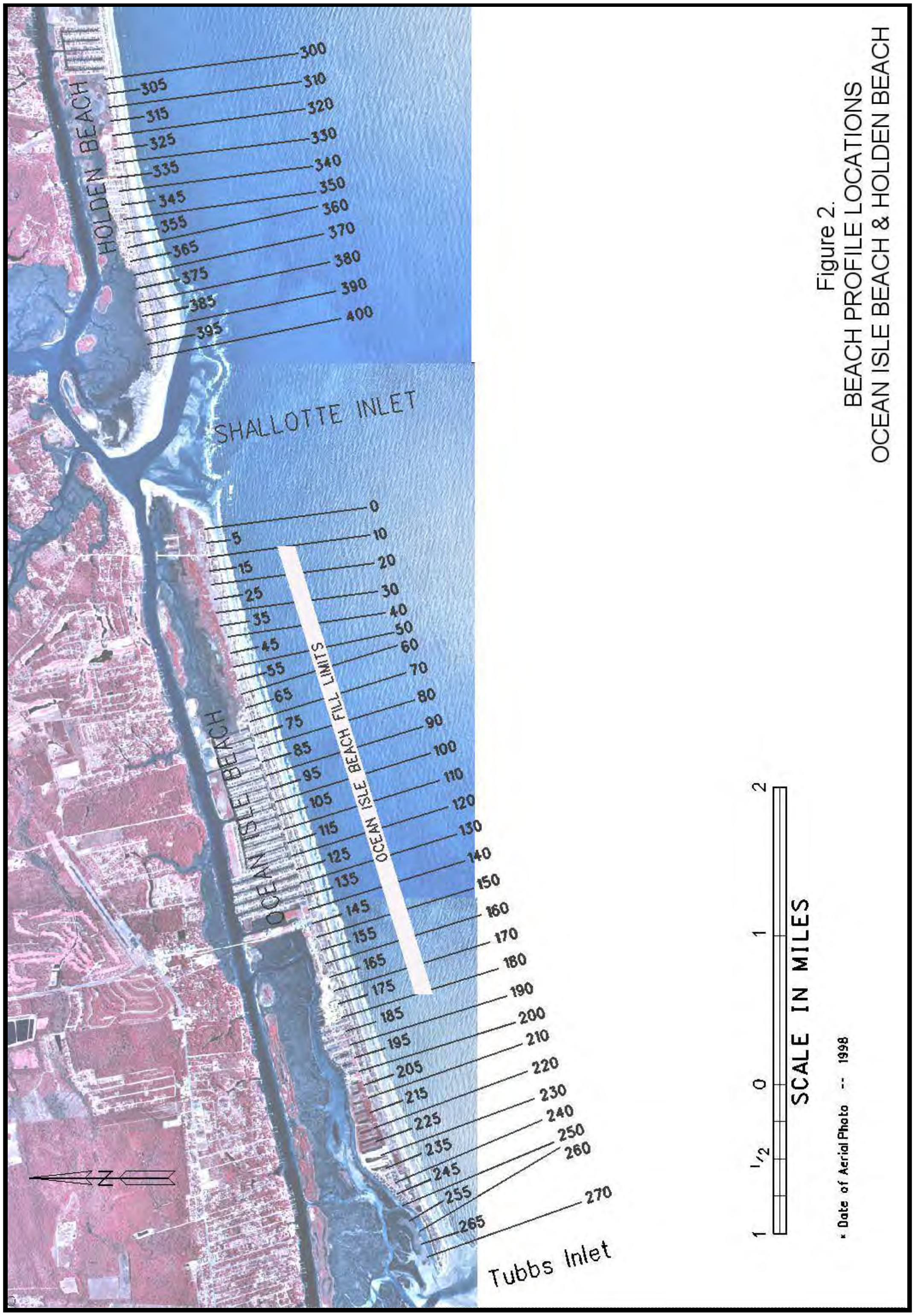


Figure 6.1. Beach profiles included in the USACE Ocean Isle Beach monitoring program (Figure copied from USACE, 2002).

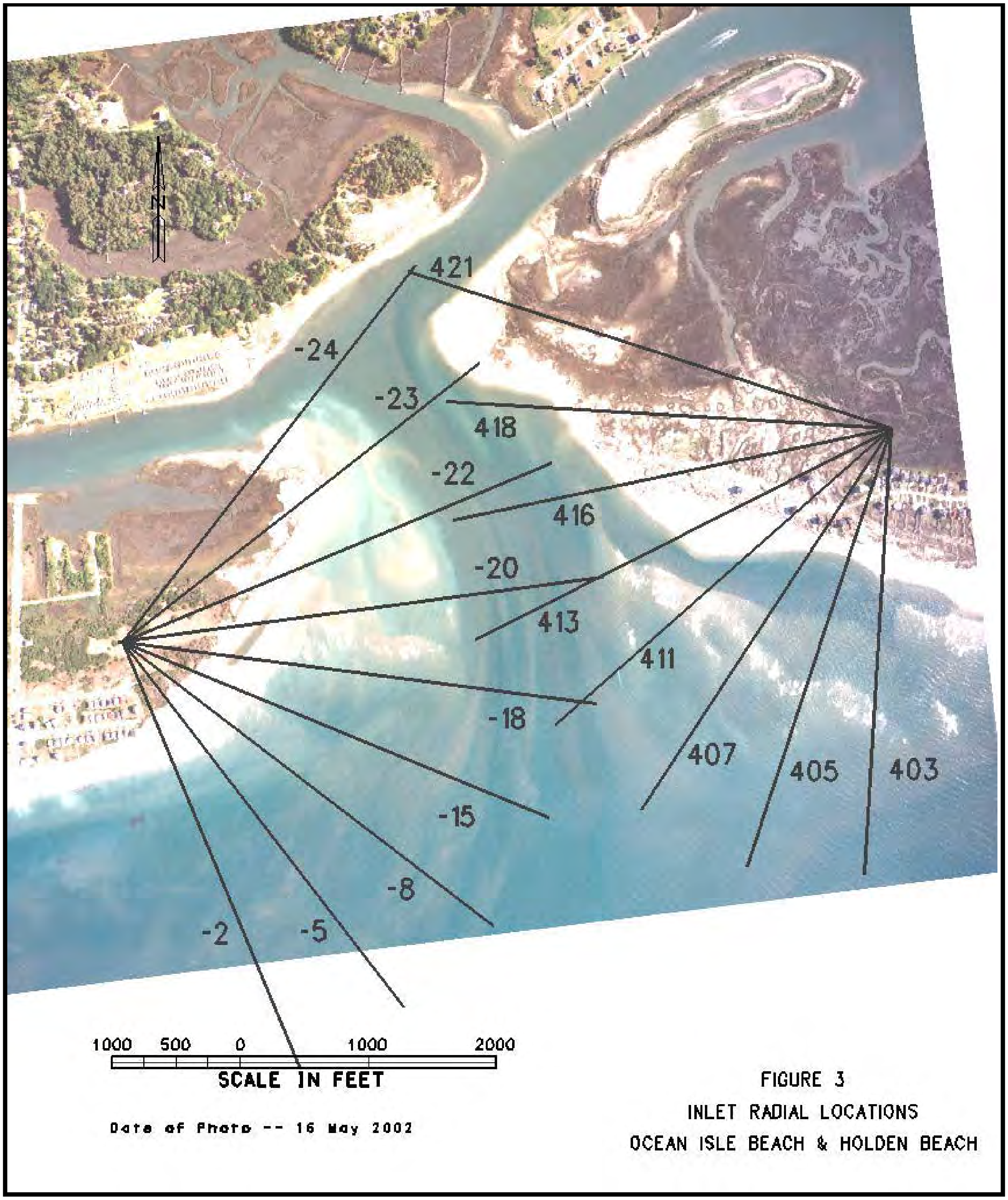


Figure 6.2. Inlet radial profiles included in the USACE Ocean Isle Beach monitoring program (Figure copied from USACE, 2002).

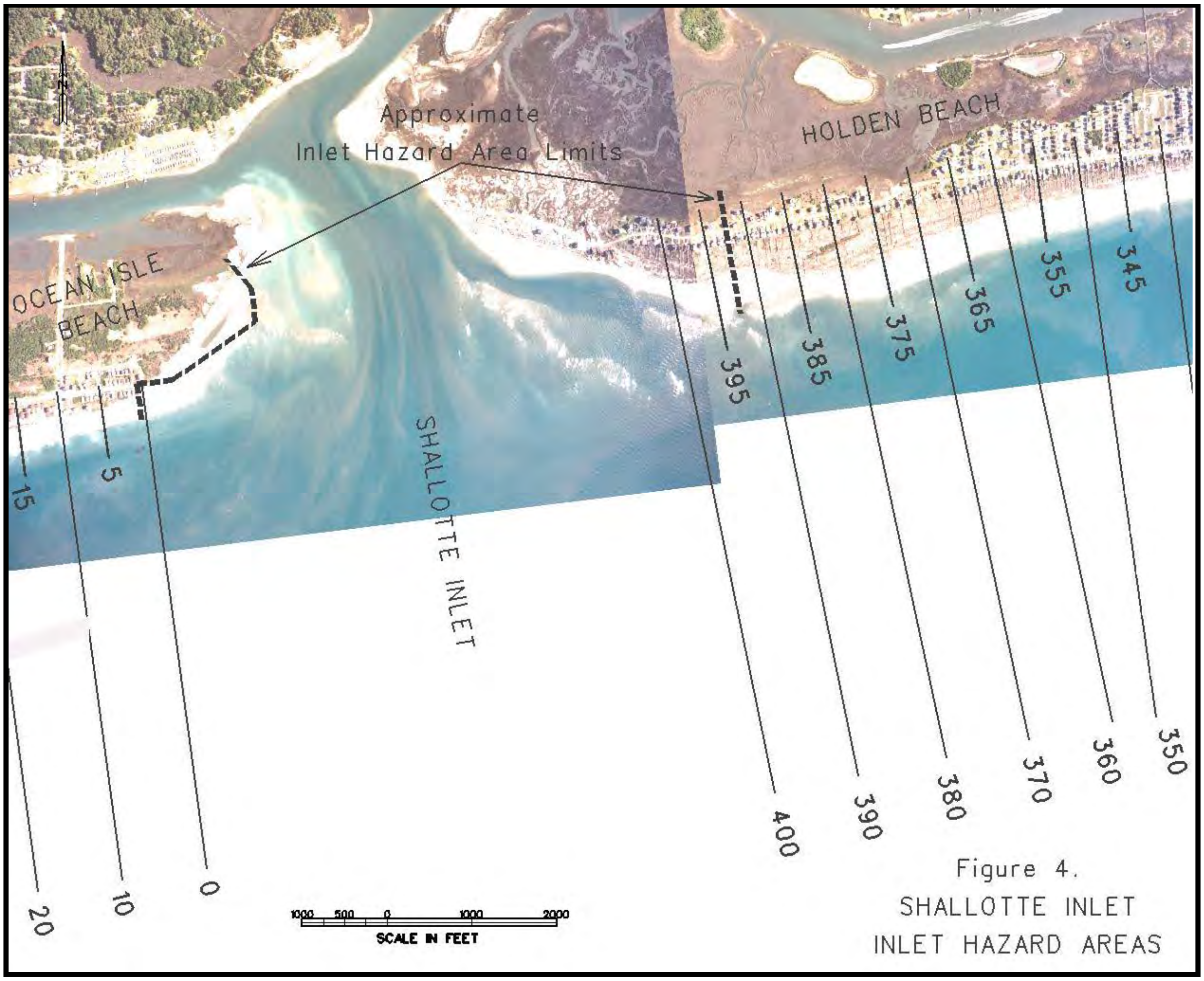


Figure 6.3. Existing Inlet Hazard Area for Shallotte Inlet (Figure copied from USACE, 2002).

Table 6.1. USACE shoreline change thresholds for Ocean Isle Beach and the west end of Holden Beach.

Ocean Isle Beach Shoreline Change Thresholds			
Beach Profile No.	Average Rate Shoreline Change (ft/yr)	Average 95% Confidence Interval (ft/yr)	Shoreline Change Rate Threshold (ft/yr)(1)
5	-2.8	4.0	-4.9
10	-4.3	2.1	-5.3
15	-4.7	1.7	-5.6
20	-3.6	1.7	-4.4
25	-1.0	1.9	-1.9
30	1.0	2.1	0.0
35	1.7	1.9	0.8
40	1.7	1.7	0.8

45	1.3	1.5	0.6
50	1.0	1.5	0.3
55	0.7	1.5	-0.1
60	0.3	1.7	-0.6
65	0.0	2.2	-1.1
70	0.1	2.9	-1.4
75	0.2	3.1	-1.3
80	0.1	3.2	-1.5
85	0.0	3.5	-1.7
90	-0.2	3.4	-1.9
95	-0.4	3.3	-2.0
100	-0.4	3.2	-2.0
105	-0.4	3.1	-1.9
110	-0.3	3.1	-1.8
115	-0.3	3.0	-1.7
120	-0.1	2.8	-1.5
125	0.1	2.5	-1.2
130	0.2	2.4	-1.0
135	0.4	2.3	-0.7
140	1.0	2.1	0.0
145	1.4	1.8	0.5
150	1.4	1.5	0.6
155	1.1	1.6	0.3
160	0.9	1.7	0.1
165	0.9	1.8	0.0
170	1.0	2.2	-0.1
175	1.1	2.5	-0.2
180	1.1	2.5	-0.1
185	1.1	2.6	-0.2
190	1.0	2.6	-0.3
200	1.1	2.6	-0.2
205	1.0	2.8	-0.4
210	1.0	2.8	-0.4
215	1.0	2.6	-0.3
220	1.1	2.5	-0.2
225	1.1	2.6	-0.2
230	1.1	2.7	-0.2
235	1.2	3.1	-0.4
240	1.3	3.4	-0.4
245	1.3	3.7	-0.5
250	1.4	4.2	-0.7

255	1.4	4.8	-1.1
260	1.6	5.6	-1.2
265	1.8	6.2	-1.3
270	1.8	6.2	-1.3

Holden Beach Shoreline Change Thresholds			
Beach Profile No.[(2)]	Average Rate Shoreline Change (ft/yr)	Average 95% Confidence Interval (ft/yr)	Shoreline Change Rate Threshold (ft/yr)[(1)]
400	2.1		1.9
395	5.5	7.3	3.3
390	7.0	7.5	3.1
385	7.1	8.0	2.0
380	6.3	8.7	0.7
375	5.3	9.3	1.9
370	4.2	9.1	-0.4
365	3.0	8.3	-1.1
360	2.1	7.4	-1.7
355	1.4	6.7	-1.9
350	1.0	5.9	-2.0
345	0.5	4.9	-1.9
340	0.3	4.4	-1.9
335	-0.2	3.7	-2.1
330	-0.6	3.2	-2.2
325	-0.8	2.5	-2.0
320	-0.9	2.0	-1.9
315	-1.2	1.7	-2.1
310	-1.7	1.5	-2.5
305	-1.7	1.3	-2.4
300	-1.7	1.2	-2.3

[(1)]Shoreline change rate threshold equal to average rate – (½ x 95% confidence interval).
[(2)]Threshold rate of 0 ft/yr adopted for profiles 375 to 400 due to influence of Shallotte Inlet bar channel.

To account for possible short term shoreline changes that could be caused by storm events or other factors, the USACE adopted a 2-year confirmation period, i.e., should observed shoreline change rate exceed the threshold rate at any profile station; an additional 2-year period would follow to confirm the trend. Should the shoreline change rate exceed the threshold over the entire 2-year confirmation period, an assessment of the proper responsive measures would be made. If the shoreline change rate decreases below the threshold rate during the confirmation period, the 2-year confirmation period would be reset.

In the event the area is impacted by a catastrophic storm such as a hurricane or severe nor'easter that causes major changes in the shoreline, subsequent shoreline change rates would likely exceed the threshold rates for some time. If after the two year post-storm confirmation period shoreline change rates are still being impacted by the storm induced changes and some of the measured shoreline change rates still exceed the threshold rates, an assessment will be made to determine if a new reference shoreline condition is needed in order to adequately evaluate potential project induced shoreline impacts that occur post storm.

Comparable shoreline change rate thresholds were not established by the USACE for the radial profile lines around the inlet's east and west shoulders (Figure 6.3) due to the variable nature of the shoreline changes and the lack of definitive shoreline trends. However, the radial transects would be monitored during the life of the project and the behavior of the inlet shorelines as depicted by the radial profiles used to determine if modifications in the Shallotte Inlet borrow area are needed.

As mentioned above, the shoreline and inlet monitoring program and shoreline change rate thresholds established by the USACE for the Ocean Isle Beach storm damage reduction project are adopted for the Ocean Isle Beach Shoreline Management Project with the exception of profiles 375 to 400 on the west end of Holden Beach which were revised based on the same protocol used to establish the thresholds at all the other transects. In this regard, should Federal funding for the monitoring program fall short in any given year, the Town of Ocean Isle Beach would provide the necessary funding to assure the program is accomplished as planned.

The Town of Ocean Isle Beach presently pays $17,000 to survey 34 profiles on the east and west end of the island, or $500 per profile. If the Town had to assume the cost of surveying the federal project between station 0+00 and 180+00, the cost to survey these 37 profiles would be an additional $18,500.

<u>Sand Spit</u>. The area on Ocean Isle Beach located east of profile station 5+00 was not included in the USACE shoreline change threshold evaluation since this area falls within the existing Inlet Hazard Area established by the NC Coastal Resources Commission. Also, the sand spit, it its present form, did not exist prior to the construction of the Federal project.

Shoreline changes along the sand spit have been highly variable as shown by the shoreline positions of the sand spit traced from Google Earth aerial photos taken between March 1999 (pre-construction) and January 2013 shown in Figure 6.5. The shorelines on Figure 6.5 do not represented a particular elevation such as mean high water or mean low water; rather the shorelines simply represent the approximate interface of the water with the dry sand beach as shown by the wet/dry line on the photos.

Based on this set of aerial photos, the eastward projection of the sand spit reached a maximum in October 2007 (yellow line in Figure 6.5). Between October 2007 and October 2010 (dark blue line), the sand spit rotated counter clockwise resulting in a landward recession of the shoreline of between 400 feet and 600 feet on the extreme eastern end of the sand spit. The re-curved nature of the sand spit normally results in the formation of a shallow pond between the old spit shoreline and the backside of the new spit. Between October 2010 and January 2013 (red line), the shoreline along the eastern end of the sand spit moved seaward 250 feet to 350 feet in response to a new slug of sand moving to the east. Eastward movement of the slug of sand stopped when it reached the main inlet channel and the sand spit again rotated counter clockwise and eventually merged with the previous sand spit. This cyclic nature of sand spit behavior should continue following the implementation of Alternative 5.

The approximate 1,000 feet of shoreline measured from the last house on the east end of Ocean Isle Beach represents the trailing end of the sand spit. Shoreline behavior in this area is also highly variable but not to the same degree as the eastern tip of the sand spit. This shoreline position variability is due in part to the movement of beach nourishment material being transported to the east off the east end of the Federal storm damage reduction project. In this regard, the October 2009 shoreline (green line in Figure 6.5), which was taken about 6 months prior to the April-May 2010 nourishment operation, had the landward most position of all of the shorelines in the photo dataset.

Even though the establishment of shoreline change thresholds at each radial transect is not practical for the spit area, the March 1999 configuration of the sand spit, as shown in Figure 6.4, is adopted as a threshold for the sand spit area on the east end of Ocean Isle Beach. Post-construction changes in the sand spit will be monitored using aerial photographs. Should the sand spit diminish in size to that comparable to the March 1999 threshold, consideration will be given to modifying the structure to allow more sediment to move from west to east past the structure.

Figure 6.4. Sand spit shorelines on east end Ocean Isle Beach – March 1999 to January 2013.

(3) Mitigation Measures. Should shoreline responses along Ocean Isle Beach or Holden Beach exceed the shoreline change thresholds presented above and continue to exceed the thresholds throughout the 2-year verification period, the terminal groin would be evaluated to determine if modifications to the structure could be made that would mitigate the negative shoreline impacts. If modification of the terminal groin would not address the problem, beach nourishment would be provided in the affected areas to compensate for the structure related impacts. This mitigative measure would be made part of an agreement between the USACE, Ocean Isle Beach, and Holden Beach.

While the establishment of shoreline change thresholds is not practical for the sand spit area, the behavior of the spit following the installation of the terminal groin would be evaluated to determine if the structure is having an obvious impact on the stability of the sand spit or if changes in the sand spit could have an negative impact on the structural integrity of the terminal groin. Should negative shoreline issues be identified along the sand spit, structural modification to the terminal groin that would increase sediment movement past the structure will be evaluated and implemented if appropriate. Should structural modifications not correct the problem, the sand spit area would be nourished during a regularly scheduled periodic nourishment event.

Should any negative shoreline impacts be detected on the west end of Holden Beach, mitigation of these impacts would be accomplished using beach fills with the fill being obtained from the Shallotte Inlet borrow area during regularly scheduled periodic nourishment events. Under the existing Federal storm damage reduction project, mitigation of adverse impacts of the Shallotte Inlet borrow area on Holden Beach would be the responsibility of the Town of Ocean Isle Beach. Separating terminal groin and borrow area impacts on the west end of Holden Beach would be difficult if not impossible. However, with the Town of Ocean Isle Beach being responsible for mitigation in both instances, identifying the culpable feature (borrow area or terminal groin) would not be required.

In the event the negative impacts of the terminal groin cannot be mitigated with beach nourishment or possible modifications to the design of the terminal groin, the terminal groin would be removed. Removal would entail the extraction of the sheet pile from the shore anchorage section and the complete removal of all stone, including bedding, underlayer, and armor stone as well as the entire structure seaward of the MHW line. All of the terminal groin construction materials would be transported off the island and placed in an appropriate storage site. The terminal groin material, particularly the sheet pile and stone, would have some salvage value; however the opinion on the cost for removal of the terminal groin, excluding any salvage value, is $2.0 million.

<u>(4) Project Modifications</u>. The terminal groin proposed for the east end of Ocean Isle Beach in the applicant’s preferred alternative (Alternative 5) is designed to allow littoral sediment to move over, through, and/or around the structure. The so-called “leaky” nature of the design, a nomenclature suggested by Olsen & Associates for the terminal groin on Amelia Island, Florida, should allow sufficient volumes of sand to move past the structure and continue east along the sand spit to maintain the integrity of the spit. As indicated above, the March 1999 configuration of the sand spit will be used as a “threshold” in determining if modifications to the structure are needed to allow more sediment to move past the structure. Consideration would also be given to possibly nourishing the area east of the terminal groin as a means of restoring the character of the sand spit. The post-construction configuration of the sand spit will be evaluated through interpretation of the aerial photographs. As stated above, should the sand spit diminish in size comparable to the March 1999 condition, consideration will be given to modifying the structure to allow more sediment to move from west to east past the structure of possibly providing beach fill to the area east of the terminal groin during regularly scheduled periodic nourishment operations. Modification to the structure could include removal of stones to increase permeability, shortening the structure, or lowering the crest elevation. The appropriate measures,

i.e., structure modifications or beach fill, would be determined following an assessment of the degree of impact the structure is having on the area.

Reporting. Annual reports, comparable to the two monitoring reports previously published by the USACE, would be prepared and submitted to the USACE Wilmington District Regulatory Office and the NC Division of Coastal Management. The reports will summarize shoreline changes observed during the previous year and will compare updated shoreline changes to shoreline change thresholds. The results will be provided in both tabular and graphical form.

Should the monitoring surveys detect shoreline change rates exceeding the threshold rates, the profile where the thresholds are exceeded will be "red flagged." Subsequent monitoring reports over the following two years will closely follow changes at these profiles to determine if corrective actions are needed.

Summary of Shoreline and Inlet Management Plan. The shoreline and inlet management plan for the Ocean Isle Beach project would include the following:

(1) Beach profile surveys every 6 months covering 27,000 feet of shoreline on Ocean Isle Beach and 10,000 feet of shoreline east of Shallotte Inlet on Holden Beach.
(2) The beach profiles will be spaced at 500-foot intervals along both Ocean Isle Beach and Holden Beach.
(3) Annual hydrographic surveys of Shallotte Inlet extending from the confluence of the inlet with the AIWW seaward to the -30-foot NAVD depth contour in the ocean. The hydrographic surveys will cover the area from approximately station 400+00 on Holden Beach to station 0+00 on Ocean Isle Beach.
(4) The 9 radial profiles on the east end of Ocean Isle Beach and the 8 radial profiles on the west end of Holden Beach, as shown in Figure 6.2, will be surveyed each spring and graphs prepared to show changes over time.
(5) The sand spit shoreline east of the terminal groin will be mapped from the aerial photos taken each spring and plots of the changes in the spit shoreline shown graphically.
(6) An annual report will be prepared summarizing changes observed during the year and identifying any profile stations where the shoreline change thresholds are exceeded.
(7) The report will include a summary of significant meteorological events (tropical and extratropical), man-made activities (beach nourishment), and any other factors that had occurred that could have an impact of past as well as future shoreline changes.
(8) The report will discuss if measures are needed to correct any observed negative shoreline impacts and if so provide recommendations on how to address the impacts.