Biological Opinion

Topsail Beach BIS Program

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Tom Augspurger / Deputy Field Supervisor — 2/20/2019

For Pete Benjamin, Field Office Supervisor — Date

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EXECUTIVE SUMMARY

This Endangered Species Act (ESA) Biological Opinion (BO) of the U.S. Fish and Wildlife Service (Service) addresses the Topsail Beach Beach, Inlet, and Sound (BIS) Program (the Action). The U.S. Army Corps of Engineers (Corps) proposes to authorize the Town of Topsail Beach to dredge material from federally-authorized channels in New Topsail Inlet, Banks Channel, Topsail Creek and the Banks Channel Connector and place the material along 24,700 linear feet (lf) of shoreline on Topsail Beach. The Corps determined that the Action is likely to adversely affect the loggerhead and green sea turtle, piping plover, red knot, and seabeach amaranth and requested formal consultation with the Service. The BO concludes that the Action is not likely to jeopardize the continued existence of these species, and is not likely to destroy or adversely modify these designated critical habitats. This conclusion fulfills the requirements applicable to the Action for completing consultation under §7(a)(2) of the ESA of 1973, as amended, with respect to these species and designated critical habitats.

The Corps also determined that the Action is not likely to adversely affect the following species, and requested Service concurrence: West Indian manatee, leatherback sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, and seabeach amaranth. The Service concurs with the findings for West Indian manatee, leatherback sea turtle, and hawksbill sea turtle. The Service does not concur with the findings for Kemp's ridley sea turtle and seabeach amaranth. We provided our basis for the concurrence decision by letter dated October 16, 2018. This concurrence fulfills the requirements applicable to the Action for completing consultation with respect to West Indian manatee, leatherback sea turtle, and hawksbill sea turtle.

The Applicant plans to dredge material from federally-authorized channels in New Topsail Inlet, Banks Channel, Topsail Creek and the Banks Channel Connector and place the material along 24,700 lf of shoreline on Topsail Beach. A primary dune will be constructed along the entire reach. A hydraulic or cutterhead dredge is proposed to be used, with sand pumped by submerged pipeline to the beachfront shoreline. All work is proposed to be conducted between November 16 and March 31.

After reviewing the current status of the species, 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 the dredging and placement of sand is not likely to jeopardize the continued existence of the piping plover, red knot, seabeach amaranth, loggerhead sea turtle, green sea turtle, and Kemp's ridley sea turtle. It is the Service's biological opinion that the dredging and placement of sand is not likely to destroy or adversely modify designated critical habitat for the Northwest Atlantic (NWA) population of the loggerhead sea turtle and designated wintering critical habitat for the piping plover. This conclusion fulfills the requirements applicable to the Action for completing consultation under §7(a)(2) of the ESA, with respect to these species.

The BO includes an Incidental Take Statement that requires the Corps to implement reasonable and prudent measures (RPMs) that the Service considers necessary or appropriate to minimize the impacts of anticipated taking on the listed species. Incidental taking of listed species that is compliance with the terms and conditions (T&C) of this statement is exempted from the prohibitions against taking under the ESA.

The Service believes the following RPMs are necessary or appropriate to minimize the impact of incidental take caused by the Action on listed wildlife species. The RPMs are described for each listed wildlife species in the subsections below.

RPMs for All Species

1. All sand placement activities above MHW must be conducted within the winter work window (November 16 to March 31).

2. Prior to sand placement, all derelict material, large amounts of rock, or other debris must be removed from the beach to the maximum extent possible.

3. Conservation Measures included in the permit applications/project plans must be implemented in the proposed project. If a RPM and T&C address the same requirement, the requirements of the RPM and T&C take precedence over the Conservation Measure.

4. During construction, trash and food items shall be disposed of properly either in predator-proof receptacles, or in receptacles that are emptied each night to minimize the potential for attracting predators of piping plovers, red knots, and sea turtles.

5. The pipeline route/pipeline placement must be coordinated with North Carolina Division of Coastal Management (NCDCM), the Corps, the Service, and the North Carolina Wildlife Resources Commission (NCWRC). Pipeline placement coordination may be accomplished through the permit application process.

6. A meeting between representatives of the Applicant and contractor(s), the Corps, the Service, the NCWRC, the permitted sea turtle surveyor(s), and other species surveyors, as appropriate, must be held prior to the commencement of work. Advance notice (of at least 10 business days) must be provided prior to conducting this meeting.

7. Access points for construction vehicles should be as close to the project site as possible. Construction vehicle travel down the beach should be limited to the maximum extent possible.

RPMs for Piping Plovers and Red Knots

8. All personnel involved in the construction or sand placement process along the beach shall be aware of the potential presence of piping plovers and red knots. Before start of work each morning, a visual survey must be conducted in the area of work for that day, to determine if piping plovers and red knots are present.

9. If project-related activities will potentially adversely affect nesting shorebirds or active nesting habitat, the Corps or Permittee must coordinate with the Service and NCWRC prior to proceeding. If the project is ongoing and shorebirds begin territorial or other nesting behaviors within the project area, then the Corps or Permittee must contact the Service and NCWRC as soon as possible.

10. The Corps or the Permittee shall clearly delineate work areas within piping plover critical habitat, such as dredge footprints, travel corridors, and access points. Disturbance within those delineated work areas must be limited to the maximum extent possible, thereby minimizing effects to sandy, sparsely-vegetated habitat within the project footprint.

RPMs for Loggerhead, Green, and Kemp's Ridley Sea Turtles

11. Only beach quality sand suitable for sea turtle nesting, successful incubation, and hatchling emergence shall be used for sand placement.

12. During dredging operations, material placed on the beach shall be qualitatively inspected daily to ensure compatibility. If the inspection process finds that a significant amount of non-beach compatible material is on or has been placed on the beach, all work shall stop immediately and the NCDCM and the Corps will be notified by the Permittee and/or its contractors to determine the appropriate plan of action.

13. Visual surveys for escarpments along the Action Area must be made immediately after completion of sand placement, and within 30 days prior to May 1, for two subsequent years after any construction or sand placement event.

14. Sand compaction must be qualitatively evaluated at least twice after each sand placement event. Sand compaction must be inspected in the project area immediately after completion of any sand placement event and one time after project completion between October 1 and May 1.

Terms and Conditions

In order for the exemption from the take prohibitions of §9(a)(1) and of regulations issued under §4(d) of the ESA to apply to the Action, the Corps must comply with the T&Cs of this statement, provided below, which carry out the RPMs described in the previous section. These T&Cs are mandatory. As necessary and appropriate to fulfill this responsibility, the Corps must require any permittee, contractor, or grantee to implement these T&Cs through enforceable terms that are added to the permit, contract, or grant document.

T&Cs for All Species

1. For the life of the permit, all sand placement activities above MHW must be conducted within the winter work window (November 16 to April 30), unless a variance is approved after additional consultation with the Service.

2. Prior to sand placement, all derelict material, large amounts of rock, or other debris must be removed from the beach to the maximum extent possible. If debris removal activities take place during shorebird breeding season (April 1– August 31), the work shall be conducted during daylight hours only.

3. Conservation Measures included in the permit applications/project plans must be implemented in the proposed project. If a RPM and T&C address the same requirement, the requirements of the RPM and T&C take precedence over the Conservation Measure.

4. During construction, trash and food items shall be disposed of properly either in predator-proof receptacles, or in receptacles that are emptied each night to minimize the potential for attracting predators of piping plovers, red knots, and sea turtles.

5. The pipeline route/pipeline placement must be coordinated with NCDCM, the Corps, the Service, and the NCWRC. Pipeline placement coordination may be accomplished through the permit application process.

6. Access points for construction vehicles should be as close to the project site as possible. Construction vehicle travel down the beach should be limited to the maximum extent possible.

7. A meeting between representatives of the contractor(s), the Corps, the Service, the NCWRC, and NCDCM, must be held prior to the commencement of work. Advance notice (of at least 5 business days) must be provided prior to conducting this meeting. The meeting will provide an opportunity for explanation and/or clarification of the Conservation Measures and T&Cs, and will include the following:
    a) Staging locations, and storing of equipment, including fuel stations;
    b) Coordination with the surveyors on required species surveys;
    c) Pipeline placement;
    d) Minimization of driving within and around the Action Area;
    e) Follow up coordination during construction and post construction;
    f) Direction of the work including progression of sand placement along the beach;
    g) Plans for compaction monitoring;
    h) Plans for escarpment surveys and
    i) Names and qualifications of personnel involved in any required species surveys.

T&Cs for Piping Plover and Red Knot

8. All personnel involved in the construction or sand placement process along the beach shall be aware of the potential presence of piping plovers and red knots. Before start of work each morning, a visual survey must be conducted in the area of work for that day, to determine if piping plovers and red knots are present. If shorebirds 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. Construction operations shall be carried out at all times in a manner as to avoid negatively impacting shorebirds and allowing them to exit the area.

9. If project-related activities will potentially adversely affect nesting shorebirds or active nesting habitat, the Corps or Permittee must coordinate with the Service and NCWRC prior to proceeding. If the project is ongoing and shorebirds begin territorial or other nesting behaviors within the project area, then the Corps or Permittee must contact the Service and NCWRC as soon as possible.

10. Piping plover habitat (sandy unvegetated habitat) within the critical habitat unit shall be avoided to the maximum extent practicable when staging equipment, establishing the dredge footprint and travel corridors. The Corps or the Permittee, to the maximum extent practicable, shall clearly delineate work areas within the critical habitat unit such as dredge footprint, travel corridors, and access points. Disturbance outside those delineated work areas must be limited, thereby minimizing effects to sandy unvegetated habitat. Driving on the beach for construction shall be limited to the minimum necessary within the designated travel corridor.

T&Cs for Sea Turtles

11. Only beach compatible fill shall 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 comprised 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 most recent version of the North Carolina Technical Standards for Beach Fill (15A NCAC 07H .0312) is considered compatible.

12. During dredging operations, material placed on the beach shall be qualitatively inspected daily to ensure compatibility. If the inspection process finds that a significant amount of non-beach compatible material is on or has been placed on the beach, all work shall stop immediately, and the NCDCM, Corps, and Bureau of Ocean Energy Management (BOEM) (as appropriate) will be notified by the permittee and/or its contractors to determine the appropriate plan of action. Required actions may include immediate removal of material and/or long-term remediation activities.

13. Visual surveys for escarpments along the Action Area must be made immediately after completion of sand placement, 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.
14. Sand compaction must be qualitatively evaluated at least twice after each sand placement event, once in the project area immediately after completion of any sand placement event

and once after project completion between October 1 and May 1. Compaction monitoring and remediation are not required if the placed material no longer remains on the beach. Within 14 days of completion of sand placement and prior to any tilling (if needed), a field meeting shall be held with the Service, NCWRC, and the Corps to inspect the project area for compaction and determine whether tilling is needed.

a) If tilling is needed for sand suitability, the area must be tilled to a depth of 36 inches. All tilling activities shall be completed prior to May 1 of any year.
b) Tilling must occur landward of the wrack line and avoid all vegetated areas that are 3 square feet or greater, with a 3-foot buffer around all vegetation.
c) If tilling occurs during the shorebird nesting season or seabeach amaranth growing season (after April 1), shorebird surveys and/or seabeach amaranth surveys are required prior to tilling.
d) A summary of the compaction assessments and the actions taken shall be included in the annual report to NCDCM, the Corps, and the Service.
e) These conditions will be evaluated and may be modified if necessary to address and identify sand compaction problems.

Monitoring and Reporting Requirements

In order to monitor the impacts of incidental take, the Corps must report the progress of the Action and its impact on the species to the Service as specified in the incidental take statement (50 CFR §402.14(i)(3)). This section provides the specific instructions for such monitoring and reporting. As necessary and appropriate to fulfill this responsibility, the Corps must require any permittee, contractor, or grantee to accomplish the monitoring and reporting through enforceable terms that are added to the permit, contract, or grant document. Such enforceable terms must include a requirement to immediately notify the Corps and the Service if the amount or extent of incidental take specified in this ITS is exceeded during Action implementation.

1. Sea turtle nesting surveys must be conducted within the project area between May 1 and November 15 of each year, for at least two consecutive nesting seasons after completion of each sand placement activity (2 years post-construction monitoring after initial construction and each maintenance event). Acquisition of readily available sea turtle nesting data from qualified sources (volunteer organizations, other agencies, etc.) is acceptable. However, in the event that data from other sources cannot be acquired, the Corps or Permittee will be responsible to collect the data. Data collected for each nest should include, at a minimum, the information in the table, below. This information will be provided to the Service's Raleigh Field Office in the annual report, and will be used to periodically assess the cumulative effects of these types of projects on sea turtle nesting and hatchling production and monitor suitability of post construction beaches for nesting. Please see REPORTING REQUIREMENTS below.

Parameter	Measurement	Variable
Number of False Crawls	Visual Assessment of all false crawls	Number/location of false crawls in nourished areas; any interaction of turtles with obstructions, such as sand bags or scarps, should be noted.
Nests	Number	The number of sea turtle nests in nourished areas should be noted. If possible, the location of all sea turtle nests should be marked on a project map, and approximate distance to scarps or sandbags measured in meters. Any abnormal cavity morphologies should be reported as well as whether turtle touched sandbags 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

2. A report describing any actions taken must be submitted to the Service's Raleigh Field Office following completion of the proposed work for each year when a sand placement activity has occurred. The report must include the following information:
    a) Project location (latitude and longitude);
    b) Project description (linear feet of beach, actual fill template, access points, and borrow areas);
    c) Dates of actual construction activities;
    d) Names and qualifications of personnel involved in sea turtle nesting surveys and relocation activities(separate the nesting surveys for nourished and non-nourished areas);
    e) Descriptions and locations of self-release beach sites; and
    f) Sand compaction, escarpment formation, and lighting survey results.

3. Seabeach amaranth surveys must be conducted within the entire oceanfront sand placement area (up to 24,000 lf) for a minimum of three years after completion of construction and each maintenance event. At a minimum, the stretches of oceanfront where sand placement occurred should be surveyed. Surveys should be conducted in August or September 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.

4. Two full years of post-construction monitoring is required for piping plovers and red knots. The piping plover and red knot survey protocol in the **Appendix (page 176)** must be followed.

Information required in the above T&C and/or these Reporting Requirements should be submitted to the following address by February 28 of each year a report is due:

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's 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.

Jason Keith
U.S. Fish and Wildlife Service
551-F Pylon Drive
Raleigh, NC 27606
919-856-4786, extension 34

In the Conservation Recommendations section, the BO outlines voluntary actions that are relevant to the conservation of the listed species addressed in this BO and are consistent with the authorities of the Corps.

Reinitiating consultation is required if the Corps retains discretionary involvement or control over the Action (or is authorized by law) when:

(a) the amount or extent of incidental take is exceeded;
(b) new information reveals that the Action may affect listed species or designated critical habitat in a manner or to an extent not considered in this BO;

(c) the Action is modified in a manner that causes effects to listed species or designated critical habitat not considered in this BO; or
(d) a new species is listed or critical habitat designated that the Action may affect.

CONSULTATION HISTORY

This section lists key events and correspondence during the course of this consultation. A complete administrative record of this consultation is on file in the Service's Raleigh Field Office.

2013-05-27, 2013-20-25, and 2013-11-22: In comments to a previous project, the Service recommended that the Corps and Applicant develop a biological assessment (BA) for this and future projects. We also recommended that the BA include a conservation measure that prevents the applicant from using portions of piping plover critical habitat Unit NC-11 as a source of sand (as described in the Town of Topsail Beach's 30-Year Management Plan). The Service also recommended that the Applicant coordinate with the permitting and resource agencies in the development of a longer-term permit.

2017-04-28 and 2018-05-10: The Service participated by phone in meetings with the Corps, NCDCM, the Applicant, and others, to discuss the proposed project. During both meetings, the Service identified concerns for potential impacts to piping plover and piping plover critical habitat, and again requested coordination on the development of long-term plans.

2018-03-30: The Corps issued a public notice for the proposed project. The Service provided comments to the public notice by letter dated April 9, 2018, recommending changes to the project to avoid and minimize impacts to wintering and migrating piping plovers.

2018-08-24: By email, the applicant's consultant provided an updated BA for the project.

2018-10-15: By emailed letter, the Corps requested initiation of formal consultation. The Service initiated formal consultation by letter dated October 16, 2018.

2018-11-28: By email, the Service provided the draft Executive Summary of the BO to the Corps, including draft RPMs and T&C.

2018-12-03: By email, the Corps informed the Service that it could comply with the RPMs and T&C.

BIOLOGICAL OPINION

1. INTRODUCTION

A biological opinion (BO) is the document that states the opinion of the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act of 1973, as amended (ESA), as to whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated critical habitat.

The Federal action addressed in this BO is the U.S. Army Corps of Engineers' (Corps) permitting decision under section 404 of the Clean Water Act in response to an application from the Town of Topsail Beach (Applicant) for the Topsail Beach BIS Renourishment Project, in Pender County, North Carolina (the Action). This BO considers the effects of the Action on piping plover, red knot, seabeach amaranth, Kemp's ridley sea turtles, the North Atlantic Ocean Distinct Population Segment (DPS) of the green sea turtle, the Northwest Atlantic Ocean DPS of the loggerhead sea turtle, and designated critical habitat for wintering piping plovers and terrestrial critical habitat for the loggerhead sea turtle.

The Corps also determined that the Action is not likely to adversely affect the following species, and requested Service concurrence: West Indian manatee, leatherback sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, and seabeach amaranth. The Service concurs with the findings for West Indian manatee, leatherback sea turtle, and hawksbill sea turtle. The Service does not concur with the findings for Kemp's ridley sea turtle and seabeach amaranth. We provided our basis for the concurrence decision by letter dated October 16, 2018. This concurrence fulfills the requirements applicable to the Action for completing consultation with respect to West Indian manatee, leatherback sea turtle, and hawksbill sea turtle.

A BO evaluates the effects of a Federal action along with those resulting from interrelated and interdependent actions, and from non-Federal actions unrelated to the proposed Action (cumulative effects), relative to the status of listed species and the status of designated critical habitat. A Service opinion that concludes a proposed Federal action is *not* likely to jeopardize species and is *not* likely to destroy or adversely modify critical habitat fulfills the Federal agency's responsibilities under §7(a)(2) of the ESA.

"*Jeopardize the continued existence*" 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 (50 CFR §402.02). "*Destruction or adverse modification*" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02).

This BO uses hierarchical numeric section headings. Primary (level-1) sections are labeled sequentially with a single digit (e.g., 2. PROPOSED ACTION). Secondary (level-2) sections within each primary section are labeled with two digits (e.g., 2.1. Action Area), and so on for level-3 sections. The basis of our opinion for each listed species and each designated critical habitat identified in the first paragraph of this introduction is wholly contained in a separate level-1 section that addresses its status, environmental baseline, effects of the Action, cumulative effects, and conclusion.

2. PROPOSED ACTION

According to the Biological Assessment (BA) for the proposed Action, the purpose of the Applicant's project is to obtain beach compatible sand in a cost-effective manner and to maintain a previously designed beach fill project, protecting property and public infrastructure within the Town of Topsail Beach. By utilizing shoal material within the navigation channels for beach nourishment, a secondary purpose of the project will be the maintenance and improvement of the shallow draft navigation channels associated with New Topsail Inlet at the southern end of Topsail Island.

The Applicant plans to dredge material from federally-authorized channels in New Topsail Inlet, Banks Channel, Topsail Creek and the Banks Channel Connector and place the material along 24,700 lf of shoreline on Topsail Beach. A primary dune will be constructed along the entire reach. A hydraulic or cutterhead dredge is proposed to be used, with sand pumped by submerged pipeline to the beachfront shoreline. All work is proposed to be conducted between November 16 and March 31.

Below, we "deconstruct" the Action into logical components for more detailed descriptions and analysis. Logical components of this action include dredging and sand placement.

2.1. Action Area

For purposes of consultation under ESA §7, the Action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). The "Action Area" for this consultation includes the ocean and estuarine shorelines of Topsail Island, New Topsail Inlet, Banks Connector, Topsail Creek, Banks Channel, Cut Through Channel and Side Channels 1 and 2, in Pender County, North Carolina (**Figure 2-1**). The Action Area includes approximately 24,700 lf (4.68 mi) of beach shoreline on Topsail Beach, north of New Topsail Inlet. The Action Area for direct impacts includes those sections of Topsail Island where sediment disposal and earthen manipulation will occur – approximately 24,700 lf of ocean and estuarine shoreline within the construction footprint, and the borrow areas/areas to be dredged in New Topsail Inlet and the estuary. The Action Area for indirect impacts, however, is much larger.

Because sea turtles, piping plovers, and red knots 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. Piping plovers

that have been documented in the project area on the south end of Topsail Island are known to migrate through other or over-winter at inlets as far south as Mason Inlet and as far north as Cape Lookout between Ocracoke Inlet and Ophelia Inlet. However, very little data has been collected on wintering and migrating piping plovers north of New River Inlet, and it would be difficult to incorporate all of these areas into an effects analysis without sufficient data. Piping plover wintering critical habitat unit NC-11 encompasses New Topsail Inlet and Rich Inlet, and many individual piping plovers have been documented at both inlets. Therefore, the Service defines the Action Area for this opinion to include the entire length of shoreline from the north end of Figure Eight Island to New River Inlet, encompassing the inlet shoulder on the north end of Figure Eight Island, all of Lea-Hutaff Island and Topsail Island, and the north end and inlet shoulder of Topsail Island (**Figure 2-2**), particularly for piping plover.

The waters in the Action Area are classified as both SA waters and Outstanding Resource Waters (ORWs). Class SA waters are surface waters suitable for shellfishing for market purposes. Waters designated as Class SA have specific water quality standards that must be met, as well as the water quality standards assigned to both Class SB and SC waters. ORWs include waters of exceptional water quality.

2.2. Dredging

The Applicant proposes to dredge material from the federally-authorized channels in New Topsail Inlet, Banks Channel, Topsail Creek and the Banks Channel Connector, including two side channels (Side Channels 1 and 2) and a "Cut Through Channel." New Topsail Inlet extends from the 12-ft contour in the ocean to the intersection of Banks Channel connector and Topsail Creek. The federally-authorized channel follows deep water rather than being a fixed channel. Banks Channel is a fixed channel, which extends from immediately southwest of the Corps Dock, to the intersection of the Atlantic Intracoastal (AIWW) near Disposal Area 186. Topsail Creek extends from the AIWW Disposal Area 203 to where it intersects the Banks Channel connector and the New Topsail Inlet channel. Topsail Creek is not a fixed channel and must follow deep water. Banks Channel connector is a deep-water channel that extends from just immediately southwest of the Corps Dock, to the intersection of Topsail Creek and New Topsail Inlet. The Applicant proposes to deepen and/or widen several of the existing channels, and to dredge a new "Cut Through Channel" which is not included in the federally-authorized channels. A hydraulic or cutterhead dredge is proposed to be used, with sand pumped by submerged pipeline to the beachfront shoreline. See **Figure 2-3** for the proposed dredging in the vicinity of New Topsail Inlet. **Table 2-1**, from the BA, indicates the federally-authorized dimensions and the proposed dimensions for this action for each of the channels.

2.3. Sand Placement

Sand placement is proposed along 24,700 lf of beach, extending south from approximately Goodwin Avenue to a point just beyond the Topsail Beach/Surf City town line, similar to previous projects in 2011 and 2014. A full primary dune will be constructed in front of the existing dune system, cresting at an elevation of 12 ft NAVD88 and with a dune crest width of 25 lf. A beach berm of varying width will be constructed to a height of 5 ft (NAVD88) with a 1:25 fill slope

extending from the waterward edge of the berm to the intertidal zone of the beach. In the proximity of the Jolly Roger Pier, dune construction will continue; however, there will be no berm construction directly adjacent to the pier structure.

Sediment used for sand placement is proposed to be beach compatible as defined in the North Carolina Department of Environmental Quality's Sediment Criteria at 15A NCAC 07H.0312. Sand will be pumped by submerged pipeline from the dredge to the beachfront shoreline. All work is proposed to be conducted between November 16 and March 31.

According to the BA, materials and equipment for the project, such as pieces of pipeline, loaders, bulldozers, off-road vehicles (ORV), and generators, will be located off the beach to the extent practicable. Construction pipes that are placed on the beach are proposed to be located as far landward as possible without compromising the integrity of the dune system. Temporary storage of pipes on the beach is proposed to be in such a manner so as not to compromise the integrity of the dune systems. There are two permanent, buried pipeline crossings from the estuarine shoreline to the beach (Drum Avenue and Queens Grant), which allows pipeline alignment from the dredge to the beach to avoid the inlet shoulder of New Topsail Inlet.

Movement of equipment that may affect listed species includes movement of the dredge and associated watercraft within the inlet and movement of earth-moving equipment, pipeline, trucks, and other ORV along the shoreline.

Artificial lighting will be used if work is conducted at night, including lighting on the dredge and work lights in the sand placement area. After work is completed, the unnatural sloped beach adjacent to the homes and other structures 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 potentially higher mortality of hatchlings.

2.4. Interrelated and Interdependent Actions

A BO evaluates the effects of a proposed Federal action. For purposes of consultation under ESA §7, the effects of a Federal action on listed species or critical habitat include the direct and indirect effects of the Action, plus the effects of interrelated or interdependent actions. "Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the Action under consideration" (50 CFR §402.02).

In its request for consultation, the Corps did not describe, and the Service is not aware of, any interrelated or interdependent actions to the Action. Therefore, this BO does not further address the topic of interrelated or interdependent actions.

2.5. Tables and Figures for Proposed Action

Figure 2-1. Topsail Beach BIS Renourishment Project Location Map from the BA (Land Management Group 2018).

Figure 2-2. Action Area for this Biological Opinion. Large black dots mark the approximate limits.

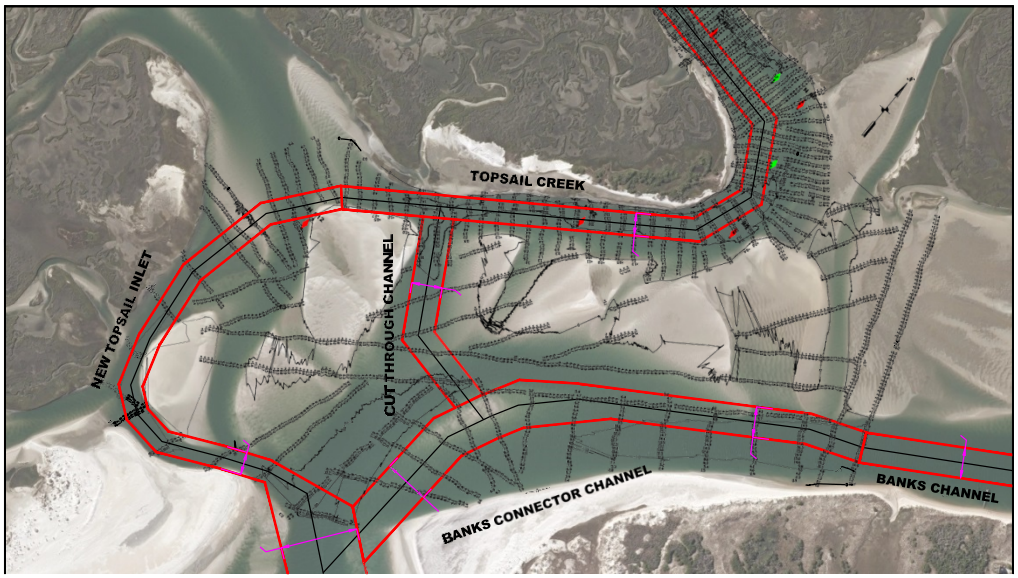


Figure 2-3. Channel alignment in New Topsail Inlet, Topsail Creek, Banks Channel, Banks Connector Channel, and Cut Through Channel (TI Coastal Services, Inc. 2018).

Table 2-1. Historical federally-authorized dimensions and the proposed dimensions for this action for each of the channels.

Channel	*Authorized Length*	*Proposed Length*	*Authorized Depth*	*Proposed Depth*	*Authorized Width*	*Proposed Width*
Topsail Inlet	8,500	8,500	8+2 (Corps) 16+2 (Town in 2013)	16+2	150	500
Banks Connector	4,000	4,000	7+2 (Corps) 16+2 (Town in 2013)	16+2	80 (Corps) 150 (Town in 2013)	300
Banks	28,300	28,300	7+2	12+2	80	200
Topsail Creek	5,000	5,000	7+2 (Corps) 12+2 (Town in 2013)	12+2	150	150
Cut Through	1,517	1,536	8+2	8+2 and 16+2	150	150 and 200
Side Channel 1	2,600	2,600	7+2	7+2	80	90
Side Channel 2	4,300	4,300	7+2	7+2	80	90

3. LOGGERHEAD, GREEN, AND KEMP'S RIDLEY SEA TURTLES

3.1. Status of Sea Turtle Species

The Service and National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) share Federal jurisdiction for sea turtles under the ESA. 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 ESA, 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. This BO addresses nesting sea turtles, their nests and eggs, and hatchlings as they emerge from the nest and crawl to the sea.

This section summarizes best available data about the biology and current condition of the Kemp's ridley (*Lepidochelys kempii*) sea turtle, the North Atlantic Ocean Distinct Population Segment (DPS) of the green sea turtle (*Chelonia mydas*), and the Northwest Atlantic (NWA) Ocean DPS of the loggerhead sea turtle (*Caretta caretta*),throughout the ranges that are relevant to formulating an opinion about the Action.

3.1.1. Description of Sea Turtle Species

3.1.1.1. 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 ESA was revised from a single threatened species to nine DPSs listed as either threatened or endangered (79 FR 39755).

Loggerheads were named for their relatively large heads, which support powerful jaws and enable them to feed on hard-shelled prey, such as whelks and conch. The carapace (top shell) is slightly heart-shaped and reddish-brown in adults and sub-adults, while the plastron (bottom shell) is generally a pale yellowish color. The neck and flippers are usually dull brown to reddish brown on top and medium to pale yellow on the sides and bottom. Hatchlings are a dull brown color. Mean straight carapace length of adults in the southeastern U.S. is approximately 36 inches (in), and mean weight is about 250 lbs.

Critical habitat for the NWA Ocean DPS of the loggerhead sea turtle is addressed in **Section 4**.

3.1.1.2. Description - Green Sea Turtle

The green sea turtle was federally listed on July 28, 1978 (43 FR 32800). On April 6, 2016, the NMFS and Service issued a final rule to list 11 DPSs of the green sea turtle. Three of the DPSs are endangered species (Central South Pacific, Central West Pacific, and Mediterranean Sea), and eight are threatened species (81 FR 20058). In North Carolina, the green sea turtle is part of the North Atlantic Ocean DPS, and is 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 (ft) 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 2009). Hatchling green turtles eat a variety of plants and animals, but adults feed almost exclusively on seagrasses and marine algae.

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.

3.1.1.3. **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 has one of the most geographically restricted distributions 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 in 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 crabs, but may also include fish, jellyfish, and an array of mollusks.

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

3.1.2. Life History of Sea Turtle Species

Sea turtles 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 sea turtles 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 ft. 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 ft.

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

Maximum intrinsic growth rates of sea turtles are limited by the extremely long duration of the juvenile stage and fecundity. Sea turtles 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).

3.1.2.1. **Life history – Loggerhead Sea Turtle**

Table 3-1 summarizes key life history characteristics for loggerheads nesting in the U.S. 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 (nesting

beaches), nearshore, and open ocean habitats. The loggerhead feeds on mollusks, crustaceans, fish, and other marine animals. The species is found hundreds of miles off shore, and in near-shore 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.

Nesting

For the NWA Ocean DPS, most 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 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 the Yucatán Peninsula of Mexico (Sternberg 1981; Ehrhart 1989; Ehrhart *et al*. 2003; NMFS and USFWS 2008).

Loggerheads nest on ocean beaches and occasionally on estuarine shorelines with suitable sand. Females dig nests typically between the high-tide line and the dune front (Routa 1968, 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).

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 of sufficient duration and standardized methods provides a valuable indicator of changes in the adult female population (Meylan 1982; Gerrodette and Brandon 2000; Reina *et al*. 2002).

Early Development

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 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.

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, 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 (Limpus 1971; Salmon *et al.* 1992; Witherington and Martin 1996; Witherington 1997; Stewart and Wyneken 2004).

3.1.2.2. **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).

3.1.2.3. **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, pers. comm., 2007 as cited in NMFS et al. 2011). 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 in 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). 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).

3.1.3. Numbers, Reproduction, and Distribution of Sea Turtle Species

3.1.3.1. Numbers, Reproduction, and Distribution – 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): South 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.

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 1,622 in 2016 (Godfrey, unpublished data; www.seaturtle.org (accessed August 30, 2018). Total estimated nesting in Florida, where 90 percent of nesting occurs, has fluctuated between 52,374 and 122,707 nests per year from 2009-2016 (FWC 2018; http://myfwc.com/media/4326434/loggerheadnestingdata12-16.pdf). 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.

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. Within the U.S., four terrestrial recovery units have been designated for the NWA Ocean DPS 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). North Carolina is located within the NRU, which is defined as loggerheads originating from nesting beaches from the Florida-Georgia border through southern Virginia (the northern extent of the nesting range). The mtDNA analyses show that there is limited exchange of females among 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 produce a relatively high percentage of males and the more southern nesting beaches produce a relatively high percentage of females (e.g., Hanson et al. 1998; NMFS 2001; Mrosovsky and Provancha 1989). The NRU and the 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 (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 the 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 NWA Ocean DPS. Annual nest totals from northern beaches averaged 5446 nests from 2006 to 2011, representing approximately 1,328 nesting females per year (4.1 nests per female, Murphy and Hopkins 1984) (NMFS and Service 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 for the NRU (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) 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
    b) 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.

3.1.3.2. **Numbers, Reproduction, and Distribution - Green Sea Turtle**

There are an estimated 150,000 green sea turtle females that nest each year in 46 sites throughout the world (NMFS and Service 2007). 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 in Florida, as well as in Georgia, South Carolina, North Carolina, and as far north as Delaware in 2011. Years of coordinated conservation efforts, including protection of nesting beaches, reduction of bycatch in fisheries, and prohibitions on the direct harvest of sea turtles, have led to increasing numbers of turtles nesting in Florida and along the Pacific coast of Mexico. On April 6, 2016, NMFS and the Service reclassified the status of the two segments that include those breeding populations (North Atlantic Ocean DPS and East Pacific Ocean DPS) from endangered to threatened (81 FR 20058). 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 1998). 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).

Range-wide Trend: Eleven DPSs have been listed for the green sea turtle (81FR20058). Three of the DPSs are listed as endangered, while eight are listed as threatened, including the North Atlantic Ocean DPS, which is included in the Action Area. The range of the DPS extends from the boundary of South and Central America, north along the coast to include Panama, Costa Rica, Nicaragua, Honduras, Belize, Mexico, and the United States, then due east across the Atlantic Ocean to the Islamic Republic of Mauritania on the African continent. It then extends west to the Caribbean basin, then due south and west to the boundary of South and Central America. It includes Puerto Rico, the Bahamas, Cuba, Turks and Caicos Islands, Republic of Haiti, Dominican Republic, Cayman Islands, and Jamaica. The North Atlantic DPS includes the Florida breeding population, which was originally listed as endangered under the ESA (43 FR 32800, July 28, 1978).

The North Atlantic Ocean DPS currently exhibits high nesting abundance, with an estimated total nester abundance of 167,424 females at 73 nesting sites. More than 100,000 females nest at Tortuguero, Costa Rica, and more than 10,000 females nest at Quintana Roo, Mexico. Nesting data indicate long-term increases at all major nesting sites. There is little genetic substructure within the DPS, and turtles from multiple nesting beaches share common foraging areas. Nesting is geographically widespread and occurs at a diversity of mainland and insular sites (81 FR 20058). 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. 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 ESA 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 mi) of all available nesting beaches (260 mi) 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.

The Recovery Plan for U.S. Population of Atlantic Green Turtle was signed in 1991 (NMFS and Service 1991), and the Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle was signed in 1998 (NMFS and Service 1998).

3.1.3.3. **Numbers, Reproduction, and Distribution – Kemp's Ridley Sea Turtle**

The Kemp's ridley has a restricted distribution. 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 mi of coastline patrolled at Rancho Nuevo, and the total number of nests documented for all the monitored beaches in Mexico was 21,144 (USFWS 2010). 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 U.S., primarily in Texas. Between 2009 and 2017 in North Carolina, there were typically one or two Kemp's ridley nests each year, and there were four in 2016.

Today, under strict protection, the population appears to be in the early stages of recovery. The recent nesting increase 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, and the requirement to use Turtle Excluder Devices (TEDs) in shrimp trawls both in the U.S. and Mexico.

The Mexico government also prohibits harvesting and is working to increase the population through more intensive law enforcement, by fencing nest areas to diminish natural predation, and by relocating most nests into corrals to prevent poaching and predation. While relocation of nests into corrals is currently a necessary management measure, this relocation and concentration of eggs into a "safe" area is of concern since it can reduce egg viability.

Recovery Criteria (only the Demographic Recovery Criteria are presented below; for the Listing Factor Recovery Criteria, see NMFS et al. 2011)
The current recovery goal is for the species to be reduced from endangered to threatened status. The Recovery Team members feel that the criteria for a complete removal of this species from the endangered species list need not be considered now, but rather left for future revisions of the plan. Complete removal from the federal list would certainly necessitate that some other instrument of protection, similar to the MMPA, be in place and be international in scope. Kemp's ridley can be considered for reclassification to threatened status when the following four criteria are met:

1. Continuation of complete and active protection of the known nesting habitat and the waters adjacent to the nesting beach (concentrating on the Rancho Nuevo area) and continuation of the bi-national protection project;
2. Elimination of mortality from incidental catch in commercial shrimping in the U.S. and Mexico through the use of TEDs and achievement of full compliance with the regulations requiring TED use;
3. Attainment of a population of at least 10,000 females nesting in a season; and
4. Successful implementation of all priority one recovery tasks in the recovery plan.

The Recovery Plan for the Kemp's Ridley Sea Turtle was signed in 1992 (USFWS and NMFS 1992). Significant new information on the biology and population status of Kemp's ridley has become available since 1992. Consequently, a full revision of the recovery plan has been completed by the Service and NMFS. The Bi-National Recovery Plan for the Kemp's Ridley Sea turtle (2011) provides updated species biology and population status information, objective and measurable recovery criteria, and updated and prioritized recovery actions.

3.1.4. Conservation Needs of and Threats to Sea Turtle Species

Reason for Listing: All sea turtle species are listed for similar reasons. 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.

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.

Threats to Sea Turtle Species

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 (NRC 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 2007a).

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 their 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 (NRC 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. In 2018, a dead female Kemp's ridley sea turtle washed up Near Fort Morgan Alabama, entangled in a beach chair (USA Today 2018).

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). The placement of rocky material may have similar effects. 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.

During project construction, predators of eggs and nestlings may be attracted to the Action Area due to food waste from the construction crew.

Sand fencing

Sand fencing captures windblown sand, bolstering dunes and altering the beach profile (Rice 2017). When fences are installed seaward of houses, the sand fencing displaces the dune crest farther seaward than would naturally occur (Nordstrom and McCluskey 1985). The installation of sand fencing in overwash areas hastens the conversion of these flat, bare areas to elevated, vegetated dune habitat. Sand fencing may impede the movement of sea turtles. Between 2012 and early 2016, 62.69 mi (19%) of sandy beach habitat in North Carolina was modified by sand fencing.

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 designed to trap sand that would otherwise be transported by longshore currents. These in-water structures can cause downdrift erosion and cause 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 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.

3.1.5. Tables and Figures for Status of Sea Turtle Species

Table 3-1. 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 in 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).

3.2. Environmental Baseline for Loggerhead, Green, and Kemp's Ridley Sea Turtles

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the three sea turtle species, respectively, sea turtle terrestrial habitat, and the ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

3.2.1. Action Area Numbers, Reproduction, and Distribution of Sea Turtles

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 3-2** for data on observed loggerhead and green sea turtle nests on Topsail Island. Data was provided from the BA and from www.seaturtle.org (accessed on August 28, 2018). The BA provided data concerning sea turtle nests within the sand placement footprint, while data from www.seaturtle.org provides the number of sea turtle nests along the entire shoreline of Topsail Island.

The green sea turtle nesting and hatching season on North Carolina beaches extends from May 15 through November 15. Incubation ranges from about 45 to 75 days. Since 2009, 11 green sea turtle nests have been documented on Topsail Island (**Table 3-2**), and according to the BA, no green sea turtle nests were documented in the project footprint between 2012 and 2016.

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 reported within the project footprint in 2016.

3.2.2. Action Area Conservation Needs of and Threats to Sea Turtles

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 3-3** lists the most recent projects in the Action Area, within the past five years, while **Table 3-4** lists BOs within the Raleigh Field Office geographic area that have been issued since 2014 for adverse impacts to sea turtle species. The total take of sea turtle habitat, issued in these BOs is 415,787 lf (78.75 mi). A State-wide Programmatic BO, issued in 2017, allows up to an additional 25 mi of take of sea turtle habitat per year for projects which meet the T&Cs of the BO (62.5 mi during years after named storms). For reference, North Carolina has approximately 323 mi of sandy shoreline, of which approximately 146 mi has been or is proposed for modification by sand placement (Rice 2017), so the amount of take allowed in the past four years in BOs approaches the total amount of historical, current, and anticipated beach placement within the state.

Nourishment activities: According to the BA, Topsail Beach has been nourished three times in the past 8 years: in the winter of 2010/2011, winter/spring of 2012, and the winter of 2013/2014.

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 USFWS 2008).
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 USFWS 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, 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.

Inlet dredging activities: According to the BA, dredging of New Topsail Inlet has been conducted on a regular basis for decades. Congressional authorization for dredging of New Topsail Inlet began as a modification to authorizations for the AIWW in 1966 (USACE 2015). The Corps conducted maintenance dredging of the shallow-draft channel two or three times per year in many years, typically using a side-cast dredge.

Beach scraping or bulldozing: 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, but data is not available for Topsail Beach.

Sandbags and revetments: 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). A sandbag revetment at least 1,800 lf long (with a geotube in front of a portion) was constructed in 2015 at the north end of North Topsail Beach, and more sandbags were recently added to protect a parking lot north of the revetment. In 2000 and 2001, sandbag revetments were installed on the north end of Figure Eight Island along Surf Court, Inlet Hook Road, and Comber Road. There are over 30 homes on Topsail Beach with existing sandbag structures.

Pedestrian Use of the Beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from beachfront and nearby residences.

Beach Driving: Topsail Beach allows vehicles on the beach between October 1 and March 28. Beach driving permits are limited to the purposes of fishing. Aerial photography indicates that vehicles frequently access all sandy portions along the inlet shoulders in New Topsail Inlet, including the estuarine shoreline. See **section 3.1.4** for discussion of the impacts of beach driving. Gibson et al. (2018) estimated the mean number of vehicles per km surveyed during winter and spring piping plover surveys. By far, Topsail Beach had the highest number of vehicles observed per km of any other site in the study (including Georgia, South Carolina, and North Carolina sites), with almost one vehicle every 2 km.

Sand fencing: There are a few stretches of sand fencing along the shoreline on Topsail Beach.

3.2.3. Tables for Environmental Baseline for Sea Turtles

Table 3-2. Number of loggerhead nests observed between 2009 and 2017 on Topsail Island and Lea-Hutaff Island. Data from the BA and from www.seaturtle.org (accessed August 28, 2018). NR = not reported.

Year	**Number of Loggerhead Nests**		**Number of Green Sea Turtle Nests**
	In Project Area	On Topsail Island	On Topsail Island
2009	NR	59	
2010	NR	104	
2011	NR	110	
2012	13	84	1
2013	20	132	4
2014	7	53	2
2015	12	67	4
2016	14	165	
2017	NR	94	

Table 3-3. Actions that have occurred on Topsail Island and/or in New Topsail Inlet.

Year	Species Impacted	Project Type	Anticipated Take
Various and ongoing, since the mid-1900s or earlier	Loggerhead, green, and Kemp's ridley sea turtle, piping plover, red knot, seabeach amaranth	Federal Navigation Projects in New Topsail Inlet and associated channels, some events with sand placement on Topsail Island	Typically 2,500 lf of shoreline, if sand is placed on beach
2011, 2012, 2015	Loggerhead, green, and Kemp's ridley sea turtle, piping plover, red knot, seabeach amaranth	Dredging of Topsail Creek, Banks Channel, Connector Channel, AIWW, with sand placement on Topsail Beach	24,700 lf of shoreline
Ongoing	Loggerhead, green, and Kemp's ridley sea turtle, piping plover, red knot, seabeach amaranth	Shallow-draft Inlet dredging, sometimes with placement on Topsail Beach	Up to 23,900 lf of shoreline

Table 3-4. Biological opinions within the Raleigh Field Office geographic area that have been issued since 2014 for adverse impacts to sea turtle species.

OPINIONS	SPECIES	HABITAT	
		Critical Habitat (loggerhead)	**Habitat**
Fiscal Year 2014: 1 BO	Loggerhead, leatherback, green, and Kemp's ridley sea turtles	12,600 lf (2.4 mi)	12,600 lf (2.4 mi)
Fiscal Year 2015: 5 BOs	Loggerhead, leatherback, green, hawksbill, and Kemp's ridley sea turtles	50,268 lf (9.5 mi)	70,268 lf (13.3 mi)
Fiscal Year 2016: 7 BOs	Loggerhead, leatherback, green, hawksbill, and Kemp's ridley sea turtles	133,150 lf (25.22 mi)	229,469 lf (45.25 mi)
Fiscal Year 2017: 2 BOs	Loggerhead, leatherback, green, hawksbill, and Kemp's ridley sea turtles	up to 25/62.5 mi annually	27,650 lf (5.24 mi) plus up to 25/62.5 mi annually
Fiscal Year 2018 (to date): 2 BOs	Loggerhead, leatherback, green, hawksbill, and Kemp's ridley sea turtles	23,000 lf (4.36 mi)	75,800 lf (14.36 mi)
Total: 17 BOs		**219,018 lf (41.48 mi) + up to 25/62.5 mi annually**	**415,787 lf (78.75 mi) plus up to 25/62.5 mi annually**

3.3. Effects of the Action on Loggerhead, Green, and Kemp's Ridley Sea Turtles

This section analyzes the direct and indirect effects of the Action on the three sea turtle species, including the direct and indirect effects of interrelated and interdependent actions. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in **Section 2** of this BO.

As discussed in **Section 3.1**, the Service and the NMFS share Federal jurisdiction for sea turtles under the ESA. The Service has responsibility for sea turtles on the nesting beach. NMFS has jurisdiction for sea turtles in the marine environment. Therefore, this BO will not consider effects of dredging on sea turtles within the marine environment (as described in **Section 2.2**).

3.3.1. Effects of Sand Placement on Sea Turtle Species

Applicable Science and Pathways of Response

Direct Effects: Potential adverse effects during the project construction phase 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. 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.

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 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). For example, in July 2018 in Atlantic Beach, NC, more than 80 hatchlings from an unmarked loggerhead sea turtle nest were rescued from the road, parking lots, and dunes after they were disoriented by artificial lights (Godfrey 2018, pers. comm.). At least one hatchling was crushed by a car on the road.

A significant reduction in sea turtle nesting activity has also been documented on beaches illuminated with artificial lights (Witherington 1992). 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 a sand placement project in Brevard County, Florida, completed in 2002. After the project, there was 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.

c. 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.

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

a. Changes in the physical environment

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 project. 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). These impacts can be minimized by using suitable sand.

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 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 (NRC 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 (NRC 1990a), and can also result in greater adverse effects due to artificial lighting, as discussed above.

Beneficial Effects: 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.

Responses and Interpretation of Effects

Sand placement activities may impact nesting and hatchling sea turtles and sea turtle nests occurring along up to 24,000 lf of shoreline in Topsail Beach. 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, and Kemp's ridley nesting females, their nests, and hatchling sea turtles. The Service expects the proposed construction activities could directly and indirectly affect the availability of habitat for nesting and hatchling sea turtles. The timing of the sand placement activities could directly and indirectly impact nesting females, their nests, and hatchling sea turtles when conducted between May 1 and November 15, although no work during the nesting season is currently proposed.

The effects of 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 U.S.

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.

The sand placement activity is a one-time activity and may take up to four and a half months 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.

For this and other sand placement BOs, the Service typically uses a surrogate to estimate the extent of take. The amount of take is directly proportional to the spatial/temporal extent of occupied

habitat that the Action affects, and exceeding this extent would represent a taking that is not anticipated in this BO. 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, nest mark and avoidance, or egg relocation program (2) the total number of hatchlings per undiscovered nest is unknown; (3) the reduction in percent hatching and emerging success per relocated nest over the natural nest site is unknown; (4) an unknown number of females may avoid the project beach and be forced to nest in a less than optimal area; (5) lights may misdirect an unknown number of hatchlings and cause death; and (6) escarpments may form and 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 sand placement activities on suitable turtle nesting beach habitat because: (1) turtles nest within the Action Area; (2) the nourishment project will modify the incubation substrate, beach slope, and sand compaction; and (3) artificial lighting will deter and/or misdirect nesting hatchling turtles.

3.4. Cumulative Effects on Loggerhead, Green, and Kemp's Ridley Sea Turtles

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. The Service is unaware of any future non-Federal Actions in the Action area that may affect sea turtles. Therefore, cumulative effects are not relevant to formulating our opinion for the Action.

3.5. Conclusion for Sea Turtle Species

In this section, we summarize and interpret the findings of the previous sections for loggerhead, green, and Kemp's ridley sea turtles (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"Jeopardize the continued existence" 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 (50 CFR §402.02).

<u>Status</u>

All three sea turtle species may nest or attempt to nest in the Action Area. Between 2009 and 2017, the annual number of recorded loggerhead turtle nests on Topsail Island has fluctuated from 53 in

2014 to 165 in 2016. 11 green sea turtle nests have been documented on Topsail Island since 2009. One Kemp's ridley turtle nest was documented within the proposed project footprint along Topsail Beach in 2016.

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.

Baseline

The Action Area has become quite developed. According to the Town of Topsail Beach's website (accessed August 28, 2018), prior to World War II, the only access to Topsail Island was by boat. During the war, large temporary Anti-aircraft training base was developed at nearby Holly Ridge, and a floating bridge was built to the island in order to develop training facilities. After the war, the Navy used Topsail Island for development of a guided missile program. After the program ended, the island was returned to the original owners, but the roads and bridge remained. Residential/commercial development began in the 1960s, and the Town of Topsail Beach was incorporated in 1963. A large portion of the Action Area is presently lined with structures, including motels, restaurants, and gift shops, along with residences. No high-rise development is allowed. Recreational use in the Action Area is quite high from residents and tourists, including vehicular driving in the winter months.

A wide range of recent and on-going 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 3-3** lists the most recent projects, within the past 5 years.

Effects

Sand placement activities may impact nesting and hatchling sea turtles and sea turtle nests occurring along up to 24,000 lf of shoreline in Topsail Beach. 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. The project would potentially impact loggerhead, green, and Kemp's ridley nesting females, their nests, and hatchling sea turtles. The Service expects the proposed construction activities could directly and indirectly affect the availability of habitat for nesting and hatchling sea turtles. The timing of the sand placement activities could directly and indirectly impact nesting females, their nests, and hatchling sea turtles when conducted between May 1 and November 15; however, work is currently not proposed within the sea turtle nesting season.

The Service determined there is a potential for long-term adverse effects on sea turtles as a result of sand placement. However, the Service acknowledges the potential benefits of the sand placement

project, since it provides additional sea turtle nesting habitat. Nonetheless, an increase in sandy beach may not necessarily equate to an increase in suitable sea turtle nesting habitat.

After reviewing the current status of the nesting sea turtle species, 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 the placement of sand is not likely to jeopardize the continued existence of the loggerhead sea turtle, green sea turtle, and Kemp's ridley sea turtle.

4. CRITICAL HABITAT FOR THE NORTHWEST ATLANTIC (NWA) POPULATION OF LOGGERHEAD SEA TURTLES

4.1. Status of Loggerhead Terrestrial Critical Habitat

This section summarizes best available data about the current condition of all designated units of critical habitat for the NWA population of the loggerhead sea turtle (*Caretta caretta*) that are relevant to formulating an opinion about the Action. On July 10, 2014, the Service designated portions North Carolina beaches as critical habitat for the NWA population of loggerhead sea turtles (79 FR 39756). Topsail Island is located within critical habitat Unit LOGG-T-NC-03 (Topsail Island, Pender County). From the Federal Register (FR) Notice (see http://www.regulations.gov/#!documentDetail;D=FWS-R4-ES-2012-0103-0001), this unit consists of 35.0 km (21.8 mi) of island shoreline along the Atlantic Ocean and extends from New River inlet to New Topsail Inlet.

4.1.1. Description of Loggerhead Terrestrial Critical Habitat

The designated units include terrestrial habitats that support nesting of the loggerhead sea turtle. In total, 1,189.9 kilometers (km) (739.3 mi) 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 mi) 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.

Critical habitat designation for the NWA population of the loggerhead sea turtle used the term "primary constituent elements" (PCEs) to identify the key components of critical habitat that are essential to its conservation and may require special management considerations or protection. Revisions to the critical habitat regulations in 2016 (81 FR 7214, 50 CFR §4.24) discontinue use of the term PCEs, and rely exclusively on the term "physical and biological features" (PBFs) to refer to these key components, because the latter term is the one used in the statute. This shift in terminology does not change how the Service conducts a "destruction or adverse modification" analysis. In this BO, we use the term PBFs to label the key components of critical habitat that provide for the conservation of the loggerhead sea turtle that were identified in its critical habitat designation rule as PCEs.

The PBFs of the NWA population of the loggerhead sea turtle critical habitat are (79 FR 39756):

(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**—Habitats Protected from Disturbance or Representative of the Historical, Geographic, and Ecological Distributions of the Species.

Sea turtle nesting habitat is part of the highly dynamic and continually shifting coastal system, which includes oceanfront beaches, barrier islands, and inlets. These geologically dynamic coastal regions are controlled by natural coastal processes or activities that mimic these natural processes, including littoral or longshore drift (the process by which sediments move along the shoreline), onshore and offshore sand transport (natural erosion or accretion cycle), and tides and storm surge. The integrity of the habitat components depends upon daily tidal events; these processes are associated with the formation and movement of barrier islands, inlets, and other coastal landforms throughout the landscape.

4.1.2. Conservation Value of Loggerhead Terrestrial Critical Habitat

The most recent comprehensive review of loggerhead terrestrial critical habitat conditions is the 2013 proposed designation of critical habitat for the NWA population of loggerhead sea turtles (78 FR 18000-18082). We summarize in this section key points from these documents that are relevant to this BO. Please refer to that document for further details.

Characterizing the current conservation value of loggerhead terrestrial critical habitat is difficult, due to the multi-state scale of the designation and to the dynamic or ephemeral nature of its PBFs. Waves, tides, currents, storms, terrestrial runoff, and biological communities interacting with sediments at the land/sea interface form and maintain loggerhead terrestrial habitats. Various human activities at the land/sea interface (construction, dredging, sand mining, sand placement, inlet stabilization/relocation/closure, seawalls, revetments, beach cleaning) disrupt these processes and reduce or degrade the PBFs. Therefore, a common and practical approach to describing the status of loggerhead terrestrial critical habitat is to quantify the extent of human alteration of features or PBFs that are easily measured at large scales.

At the time of designation, the entire designated critical habitat is occupied, and all of the designated critical habitat contains, to different degrees, the PBFs essential to the conservation of the species in the terrestrial environment. The high-density nesting beaches designated as critical habitat units have the highest nesting densities within the each of the four recovery units, and have a good geographic spatial distribution that will help ensure the protection of genetic diversity. The

critical habitat units next to the primary high-density nesting units currently support loggerhead nesting and can serve as expansion areas should the high-density nesting beaches be significantly degraded or temporarily or permanently lost.

Threats to loggerhead sea turtle terrestrial habitat

Most of the threats listed below are discussed in more detail in **Section 3.1.2**, above, and in the March 25, 2013 proposed designation (78 FR 18000-18082).

Recreational beach use: beach cleaning (including rock-picking), human presence (e.g., dog beach, special events, piers, and recreational beach equipment). Beach cleaning is increasing in the southeastern U.S., especially in Florida. Beach cleaning also occurs in a few locations in South Carolina, North Carolina, and Alabama. Human presence on the beach at night during the nesting season may reduce the quality of nesting habitat by deterring or disturbing nesting sea turtles and causing them to avoid otherwise suitable habitat. Recreational beach equipment, such as lounge chairs and umbrellas, left 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 false crawls at these obstacles is becoming increasingly common as more recreational beach equipment is left on the beach at night.

Beach driving: essential and nonessential off-road vehicles, all-terrain vehicles, and recreational access and use. Beach driving has been found to reduce the quality of loggerhead nesting habitat in several ways. In the southeastern U.S., vehicle ruts on the beach have been found to prevent or impede hatchlings from reaching the ocean following emergence from the nest (Hosier et al. 1981; Cox et al. 1994; Hughes and Caine 1994). Sand compaction by vehicles has been found to hinder nest construction and hatchling emergence from nests (Mann 1977). Vehicle lights and vehicle movement on the beach after dark results in reduced habitat suitability, which can deter females from nesting and disorient hatchlings. If driving occurs at night, sea turtles could be run over and injured. Additionally, vehicle traffic on nesting beaches contributes to erosion, especially during high tides or on narrow beaches where driving is concentrated on the high beach and foredune.

Predation: depredation of eggs and hatchlings by native and nonnative predators. Predation of sea turtle eggs and hatchlings by native and nonnative species occurs on almost all nesting beaches. Predation by a variety of predators can considerably decrease sea turtle nest hatching success. In addition, nesting turtles harassed by predators (e.g., coyotes, red foxes) on the beach may abort nesting attempts (Hope 2012, pers. comm.). Thus, the presence of predators can affect the suitability of nesting habitat.

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. Substantial amounts of sand are deposited along Gulf of Mexico and Atlantic Ocean beaches to protect coastal properties in anticipation of preventing erosion and what otherwise would be considered natural processes of overwash and island migration. Constructed beaches tend to differ from natural beaches in several important ways for sea turtles. They are typically wider, flatter, and more compact, and the sediments are moister than those on natural beaches (Nelson et al. 1987; Ackerman et al. 1991; Ernest and Martin 1999). On

severely eroded sections of beach, where little or no suitable nesting habitat previously existed, sand placement can result in increased nesting (Ernest and Martin 1999). There are important ephemeral impacts associated with beach sand placement activities. In most cases, a significantly larger proportion of turtles emerging on engineered beaches abandon their nesting attempts than turtles emerging on natural or pre-nourished beaches, even though more nesting habitat is available (Trindell et al. 1998; Ernest and Martin 1999; Herren 1999), with nesting success approximately 10 to 34 percent lower on nourished beaches than on control beaches during the first year post-nourishment. 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 (beach profile, sediment grain size, beach compaction, frequency and extent of escarpments) associated with the nourishment project (Ernest and Martin 1999). 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 beach conditions. Also during the first post-construction year, nests on nourished beaches are deposited significantly more seaward of the toe of the dune 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.

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. Many navigable mainland or barrier island tidal inlets along the Atlantic and Gulf of Mexico coasts are stabilized with jetties or groins. 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 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 loggerhead 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.

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. Coastal development not only causes the loss and degradation of suitable nesting habitat, but can result in the disruption of powerful coastal processes accelerating erosion and interrupting the natural shoreline migration. This may in turn cause the need to protect upland structures and infrastructure by armoring, which causes changes in additional loss of, or impact to the remaining sea turtle habitat. In the southeastern U.S., numerous armoring or erosion control structures (e.g., bulkheads, seawalls, soil retaining walls, rock revetments, sandbags, geotextile tubes) that create barriers to nesting have been constructed to protect upland residential

and commercial development. Armoring is any rigid structure placed parallel to the shoreline on the upper beach to prevent both landward retreat of the shoreline and inundation or loss of upland property by flooding and wave action (Kraus and McDougal 1996). Although armoring structures may provide short-term protection to beachfront property, they do little to promote or maintain sandy beaches used by loggerhead sea turtles for nesting. These structures influence natural shoreline processes and the physical beach environment, but the effects are not well understood. However, it is clear that armoring structures prevent long-term recovery of the beach and dune system by physically prohibiting dune formation from wave uprush and wind-blown sand movement.

In addition to coastal armoring, there are a variety of other coastal construction activities that may affect sea turtles and their nesting habitat. These include construction, repair, and maintenance of upland structures and dune crossovers; installation of utility cables; installation and repair of public infrastructure (such as coastal highways and emergency evacuation routes); and construction equipment and lighting associated with any of these activities. Many of these activities alter nesting habitat, as well as directly harm adults, nests, and hatchlings. Most direct construction-related impacts can be avoided by requiring that nonemergency activities be performed outside of the nesting and hatching season.

Artificial lighting: direct and indirect lighting, skyglow, and bonfires. Coastal development contributes to habitat degradation by increasing light pollution (Witherington and Martin 1996). Experimental studies have shown that artificial lighting deters adult female turtles from emerging from the ocean to nest (Witherington 1992). Witherington (1986) also found that loggerheads aborted nesting attempts at a greater frequency in lighted areas. In addition, because adult females rely on visual brightness cues to find their way back to the ocean after nesting, those turtles that nest on lighted beaches may become disoriented by artificial lighting and have difficulty finding their way back to the ocean. Hatchlings, unable to find the ocean or delayed in reaching it, are likely to incur high mortality from dehydration, exhaustion, or predation (Carr and Ogren 1960; Ehrhart and Witherington 1987; Witherington and Martin 1996). Based on hatchling orientation index surveys at nests located at 23 representative beaches in six counties around Florida in 1993 and 1994, Witherington et al. (1996) found that, by county, approximately 10 to 30 percent of nests showed evidence of hatchlings disoriented by lighting. Mortality of disoriented hatchlings is likely very high (NMFS and USFWS 2008).

Beach erosion: erosion due to aperiodic, short-term weather-related erosion events, such as atmospheric fronts, northeasters, tropical storms, and hurricanes. Natural beach erosion events may influence the quality of nesting habitat. Short-term erosion events (e.g., atmospheric fronts, northeasters, tropical storms, and hurricanes) are common phenomena throughout the NWA loggerhead nesting range and may vary considerably from year to year. Although these erosion events may affect loggerhead hatchling production, the results are generally localized and they rarely result in whole-scale losses over multiple nesting seasons. The negative effects of hurricanes on low-lying and developed shorelines used for nesting by loggerheads may be longer-lasting and a greater threat overall. Hurricanes and other storm events 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 affect sea turtles by causing the loss of nesting habitat. Depending on their frequency, storms can affect sea turtles on either a short-

or long-term basis. 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. When combined with the effects of sea level rise (see the threat category for climate change below for additional information), there may be increased cumulative impacts from future storms.

Climate change: including sea level rise. Climate change has the potential to impact loggerhead sea turtles in the Northwest Atlantic. The decline in loggerhead nesting in Florida from 1998 to 2007, as well as the recent increase, appears to be tied to climatic conditions (Van Houtan and Halley 2011). Global sea level during the 20th century rose at an estimated rate of about 1.7 millimeters (mm) (0.7 in) per year or an estimated 17 centimeter (cm) (6.7 in) over the entire 100-year period, a rate that is an order of magnitude greater than that seen during the several millennia that followed the end of the last ice age (Bindoff et al. 2007). Potential impacts of climate change to NWA loggerheads include beach erosion from rising sea levels, repeated inundation of nests, skewed hatchling sex ratios from rising incubation temperatures, and abrupt disruption of ocean currents used for natural dispersal during the complex life cycle (Fish et al. 2005; Hawkes et al. 2009). 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 loggerhead nesting habitat and nesting females and their eggs. The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the intensity of storms and/ or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Kennedy et al. 2002; Meehl et al. 2007).

Habitat obstructions: tree stumps, fallen trees, and other debris on the beach; nearshore sand bars; and ponding along beachfront seaward of dry beach. Both natural and anthropogenic features can act as barriers or deterrents to adult females attempting to access a beach. In addition, hatchlings often must navigate through a variety of obstacles before reaching the ocean. These include natural and human-made debris. Research has shown that travel times of hatchlings from the nest to the water may be extended when traversing areas of heavy foot traffic or vehicular ruts (Hosier et al. 1981); the same is true of debris on the beach. Hatchlings may be upended and spend both time and energy in righting themselves. Some beach debris may have the potential to trap hatchlings and prevent them from successfully reaching the ocean. In addition, debris over the tops of nests may impede or prevent hatchling emergence.

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. Oil spills threaten loggerhead sea turtles in the Northwest Atlantic. Oil spills in the vicinity of nesting beaches just prior to or during the nesting season place nesting females, incubating egg clutches, and hatchlings at significant risk from direct exposure to contaminants (Fritts and McGehee 1982; Lutcavage et al. 1997; Witherington 1999), as well as negative impacts on nesting habitat. Oil cleanup activities can also be harmful. Earth-moving equipment can dissuade females from nesting and destroy nests, containment booms can entrap hatchlings, and lighting from nighttime activities can misdirect turtles (Witherington 1999)

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. The presence of soldiers and other personnel on the beach, particularly at night during nesting and hatching season, could result in harm or death to individual nesting turtles or hatchlings, as well as deter females from nesting. Training exercises require concentration and often involve inherently dangerous activities. A nesting sea turtle or emerging hatchling could be overlooked and injured or killed by training activities on the beach. Training activities also may require the use of pyrotechnics and lighting, and both nesting and hatchling sea turtles are adversely affected by the presence of artificial lighting on or near the beach (Witherington and Martin 1996). The use of vehicles for amphibious assault training, troop transport, helicopter landing drops and extraction, search and rescue, and unmanned aerial vehicle use all have the potential to injure or kill nesting females and emerging hatchlings. In addition, heavy vehicles have the potential to compact sand that may affect the ability of hatchlings to climb out of nests or create ruts that entrap hatchlings after emergence. Live fire exercises are inherently dangerous, and spent ammunition could injure or kill sea turtles and hatchlings, particularly at night. A nesting sea turtle or emerging hatchling could approach the beach area during an exercise and be harmed or killed. Digging into the sand to place or remove objects (e.g., mine placement and extraction) could result in direct mortality of developing embryos in nests within the training area for those nests that are missed during daily nesting surveys and thus not marked for avoidance.

4.1.3. Conservation Needs for Loggerhead Terrestrial Critical Habitat

Under the definition of critical habitat in the ESA, PBFs are both "essential to the conservation of the species" and "may require special management considerations or protection" (ESA §3(5)(A)(i)).

Within the designated critical habitat units for the NWA population of the loggerhead sea turtle, sites for breeding and reproduction of offspring (PBF 1) are managed or protected in many states. Some beach communities, local governments, and State and Federal lands have management plans, agreements, or ordinances that prohibit beach driving during the nesting season, and also address recreational equipment on the beach to minimize impacts to nesting and hatchling loggerhead sea turtles. It is more difficult to maintain protected habitats from disturbance or habitats representative of the historical, geographic, and ecological distributions of the species (PBF 2) on a large scale. Across the southeastern U.S., areas where natural coastal processes are allowed to occur are almost exclusively located on protected state and federal lands; however, even these areas are subject to increasing pressure to nourish beaches and allow beach driving or other forms of increased recreational access.

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. Beach sand placement projects conducted under the Service's Statewide Programmatic Biological Opinion for the Corps' planning and regulatory sand placement activities (including post-disaster sand placement activities) in Florida and North Carolina, and other individual biological opinions throughout the loggerhead's nesting range include required terms and conditions that minimize incidental take of turtles and protect sand quality and compatibility for nesting sea turtles.

Efforts are underway to reduce light pollution on sea turtle nesting beaches. In the southeastern U.S., the effects of light pollution on sea turtles are most extensive in Florida due to dense coastal development. Enforcement of mandatory lighting ordinances in Florida and other States has increased.

The Service consults with the Department of Defense under section 7 of the ESA on their Integrated Natural Resources Management Plans, military mission, testing, and training activities that may affect nesting and hatchling sea turtles, sea turtle nests, and sea turtle nesting habitat. Efforts to minimize the effects of these activities including natural resource management have focused on adjusting the activity timing to minimize encounters with loggerheads and adjusting locations of activities to reduce overlap with sea turtle habitats.

The Service acknowledges that we cannot fully address the significant, long-term threat of natural beach erosion, climate change, or natural disasters to loggerhead sea turtles. However, we can determine how we respond to the threats by providing protection to the known nesting sites. We can also identify measures to protect nesting habitat from the actions undertaken to respond to those natural changes. Likewise, coastal development is difficult to manage with respect to sea turtle protection, and is likely to result in long-term or recurrent impacts to sea turtle nesting habitat from increased threats in almost all of the threat categories.

4.2. Environmental Baseline for Loggerhead Terrestrial Critical Habitat

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of designated critical habitat for loggerhead sea turtles within the Action Area. The environmental baseline is a "snapshot" of the condition of the PBFs that are essential to the conservation of the species within designated critical of the Action Area at the time of the consultation, and does not include the effects of the Action under review.

4.2.1. Action Area Conservation Value of Loggerhead Terrestrial Critical Habitat

For the NRU, the Service has designated 393.7 km (244.7 mi) of Atlantic Ocean shoreline in North Carolina, South Carolina, and Georgia, encompassing approximately 86 percent of the documented number of nests within the recovery unit. The eight critical habitat units in North Carolina total 96.1 mi (154.6 km) of beach. 15.1 mi (24.3 km) are located within state-owned lands, while 81 mi (130.3 km) are on land owned by private parties or others, such as counties and municipalities.

As stated in **Section 4.1**, Topsail Beach is located within critical habitat Unit LOGG-T-NC-03. This unit has high-density nesting by loggerhead sea turtles in North Carolina. This critical habitat unit is one of 38 designated critical habitat units for the Northern Recovery Unit of the NWA Ocean DPS. Up to a quarter of this acreage has been affected recently by activities such as beach nourishment and sandbag revetment construction, or is proposed for such activities. However, with the exception of beach nourishment activities, sandbags, groin construction, and recreational activities, most of the critical habitat units in North Carolina remain relatively unaffected by development

The units in North Carolina contain both of the PBFs, although some have more stressors than others. The critical habitat unit in the Action Area provides important nesting habitat in the northern portion of the loggerheads breeding range, and due to cooler sand temperatures, may provide greater numbers of male hatchlings than beaches to the south. 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.

4.2.2. Action Area Conservation Needs for and Threats to Loggerhead Terrestrial Critical Habitat

The Action Area is developed and most of it is under private ownership that may support new coastal development. Residential and commercial development began in the mid-1960's. Large portions of the Action Area are presently lined with structures. Recreational use in the Action Area is quite high from residents and tourists, including beach driving in the winter. The Action Area and adjacent beaches are managed in order to protect sea turtle nesting habitat by prohibiting beach driving within the nesting season, and local ordinances requiring the removal of beach equipment and chairs after sundown. A local volunteer organization conducts daily monitoring of sea turtle nests during the nesting season.

A wide range 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 3-3** lists the most recent projects, within the past 5 years. The threats to loggerhead terrestrial critical habitat in the Action Area are the same as those to sea turtles in general. See **Section 3.2.2** for threats within the Action Area.

4.3. Effects of the Action on Loggerhead Terrestrial Critical Habitat

This section analyzes the direct and indirect effects of the Action on critical habitat for loggerhead sea turtles, which includes the direct and indirect effects of interrelated and interdependent actions. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur.

4.3.1. Effects of Sand Placement on Loggerhead Terrestrial Critical Habitat

Sand placement activities may impact loggerhead terrestrial critical habitat along up to 24,000 lf of shoreline in Topsail Beach. Sand placement activities would occur within designated critical habitat.

The sand placement activity is a one-time activity and is expected to take up to four and a half months to complete. Thus, the direct effects would be expected to be short-term in duration. Indirect effects from the activity may continue to loggerhead terrestrial critical habitat in subsequent nesting seasons.

Applicable Science and Pathways of Response

Direct Effects: Potential adverse effects to loggerhead terrestrial critical habitat include many of the indirect effects to sea turtle species, discussed in **Section 3.3.1**. Placement of sand on a beach may adversely affect PBFs 1 and 2. Driving on the beach can also cause sand compaction, which may result in adverse impacts on nest site selection, digging behavior, clutch viability, and emergence by 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, potentially adversely affecting PBFs 1 and 2. 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).

Artificial lighting as a result of an unnatural beach slope may adversely affect PBFs 1 and 2. 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.

Changes in the physical environment as a result of the project may adversely affect PBF 2. Beach nourishment projects create an elevated, wider, and unnatural flat slope berm, and may result in an unnatural sediment grain size distribution (Ernest and Martin 1999; Trindell 2005).

Incompatible sediment and unnatural beach profiles resulting from beach nourishment activities could negatively impact PBFs 1 and 2. Very fine sand or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson et al. 1987; Nelson and Dickerson 1988a). Large amounts of rock or gravel can also cause issues for females attempting to construct a nest and hatchlings attempting to egress a nest. 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 and sediment grain size 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.

Escarpment formation may adversely affect PBFs 1 and 2. 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 can hamper or prevent access to nesting sites (Nelson and Blihovde 1998). This impact can be minimized by leveling any escarpments prior to the nesting season.

Increased beachfront development may adversely affect PBF 2. 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.

Beneficial Effects: 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.

4.4. Cumulative Effects on Loggerhead Terrestrial Critical Habitat

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. The Service is unaware of any future non-Federal Actions in the Action area that may affect loggerhead critical habitat. Therefore, cumulative effects are not relevant to formulating our opinion for the Action.

4.5. Conclusion for Loggerhead Terrestrial Critical Habitat

In this section, we summarize and interpret the findings of the previous sections for loggerhead sea turtle critical habitat (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"*Destruction or adverse modification*" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02).

Status

The entire designated critical habitat for the NWA Population of the loggerhead sea turtle is occupied, and all of the designated critical habitat contains the PBFs essential to the conservation of the species in the terrestrial environment. The high-density nesting beaches designated as critical habitat units have the highest nesting densities within the each of the four recovery units, and have a good geographic spatial distribution that will help ensure the protection of genetic diversity. The critical habitat units next to the primary high-density nesting units currently support loggerhead nesting and can serve as expansion areas should the high-density nesting beaches be significantly degraded or temporarily or permanently lost.

Baseline

This critical habitat unit (LOGG-T-NC-03; Topsail Island) is one of 38 designated critical habitat units for the Northern Recovery Unit of the NWA Ocean DPS. In North Carolina, 96.1 shoreline mi (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 and sandbag revetment

construction. However, with the exception of beach nourishment activities, sandbags, and recreational activities, most of the critical habitat units in North Carolina remain relatively unaffected by development.

The units in North Carolina contain both of the PBFs, and all function relatively well. The CH units in the Action Area provide important nesting habitat in the northern portion of the loggerheads breeding range, and due to cooler sand temperatures, may provide greater numbers of male hatchlings than beaches to the south.

Effects

PBF 1 and PBF 2 may be adversely affected by the use of heavy equipment on the beach, artificial lighting (resulting from an unnatural beach slope), changes in the physical environment, including placement of incompatible sediment, unnatural beach profiles, changes in sediment color, escarpment formation, and increased beachfront development. The placement of sand on a beach with reduced dry foredune habitat may also have a beneficial effect if the sand is highly compatible. These adverse impacts are limited to the Action Area.

After reviewing the current status of the critical habitat, the environmental baseline for the Action Area, the effects of the Action, and the cumulative effects, it is the Service's biological opinion that the Action is not likely to destroy or adversely modify designated critical habitat for the NWA Ocean DPS of the loggerhead sea turtle.

5. PIPING PLOVER

5.1. Status of Piping Plover

This section summarizes best available data about the biology and current condition of piping plover (*Charadrius melodus*) throughout its range that are relevant to formulating an opinion about the Action. 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).

Multiple recovery plans and 5-year reviews have been developed for the three piping plover populations since listing, including a 1988 recovery plan and 1994 revised draft recovery plan for the Great Lakes and Northern Great Plains populations (USFWS 1998; USFWS 1994), a 1996 revised recovery plan for the Atlantic Coast breeding population (USFWS 1996a), a 2003 recovery plan for the Great Lakes population (USFWS 2003a), a document outlining the comprehensive conservation strategy (CCS) for the piping plover in its coastal migration and wintering range (USFWS 2012), and a 2016 recovery plan for the Northern Great Plains piping plover (USFWS 2015), which incorporates an updated CCS.

Our most recent 5-year status review of the species recommended retaining the current ESA classification (USFWS 2009c). The status review also summarized data that would support classifying the piping plover for ESA purposes as two subspecies, *C. m. melodus* (Atlantic Coast

breeding population), and *C. m. circumcinctus.* Additional data would support classifying the latter as two discrete breeding populations: (a) the Northern Great Plains of the U.S. and Canada, and (b) the Great Lakes watershed of the U.S. and Canada. However, the review concludes that revising the classification accordingly would have little regulatory or conservation effect, because the current classification appropriately represents the status of the three breeding populations.

5.1.1. Description of Piping Plover

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).

North Carolina is one of the only states where piping plovers' breeding and wintering ranges overlap and the birds are present year-round. 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 2012 analysis shows strong patterns in the wintering distribution of piping plovers from different breeding populations (Gratto-Trevor et al. 2012), partitioning is not complete and major information gaps persist.

5.1.2. Life History of Piping Plover

Named for its melodic mating call, the piping plover is a pale-colored shorebird about the size of a robin. Length is 17–18 cm; weight is 43–63 g. Plumage, bill, and leg coloration are slightly different between the breeding season and winter, between juveniles and adults, and between males and females. 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 (Audubon Society 2017). Plovers are known to begin breeding as early as one year of age (MacIvor 1990; Haig 1992). In studies with large numbers of marked interior breeding piping plovers, Saunders et al. (2014) found that 56 percent of female Great Lakes piping plovers mated in their first season post-hatch, while 68 percent of female yearlings mated in Saskatchewan in 2001-2006 (Gratto-Trevor et al. 2010). Both studies found that probability of breeding in the first year was lower for males than females, but Great Lakes males that had not bred earlier were more likely than females to recruit into the breeding population in years two and three. Virtually all surviving Great Lakes piping plovers began breeding by year three (Saunders et al. 2014). 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 2009a).

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 2009a);
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).
e. 2016 Draft Revised Recovery Plan for the Northern Great Plains population of Piping Plover (USFWS 2015).

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. The species requires broad, open, sand flats for feeding, and undisturbed flats with low dunes and sparse dune grasses for nesting. 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). Following establishment of nesting territories and courtship rituals, the pair forms a depression in the sand, where the female lays her eggs. 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. Chicks are precocial, often leaving the nest within hours of hatching, but are tended by adults who lead the chicks to and from feeding areas, shelter them from harsh weather, and protect the young from perceived predators. Chicks remain together with one or both parents until they fledge (are able to fly) at 25 to 35 days of age. By early September both adults and young depart for their wintering areas.

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). Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging and roosting (Nicholls and Baldassarre 1990; Drake 1999a; 1999b; Maddock et al. 2009). 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). 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.

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 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.

Piping plovers exhibit a high degree of intra- and interannual wintering site fidelity (Nicholls and Baldassarre 1990b; Drake et al. 2001; Noel and Chandler 2008; Stucker and Cuthbert 2006; Gibson et al. 2017). 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 mi by approximately 10 percent of the banded population. Larger movements within South Carolina were seen during fall and spring migration.

5.1.3. Numbers, Reproduction, and Distribution of Piping Plover

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). Although there are shortcomings in the census method, it is the largest known, complete avian species census. The 2011 survey documented 2,391 breeding pairs, with a total of 5,723 birds throughout Canada and the U.S. (Elliot-Smith et al. 2015).

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; Amirault et al. 2005; Calvert et al. 2006; Brault 2007; Gibson et al. 2018) 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, Drake et al. (2001) observed no mortality among 49 radio-marked piping plovers (total of 2,704 transmitter-days) in Texas in the

1990s. Cohen et al. (2008) also reported no mortality among a small sample (n=7) of radio-marked piping plovers at Oregon Inlet, North Carolina in 2005-2006.

Northern Great Plains Population

The Northern Great Plains plover breeds from Alberta to Manitoba, Canada and south to Nebraska; although some nesting has occurred in Oklahoma (Boyd 1991). Currently the most westerly breeding piping plovers in the U.S. occur in Montana and Colorado.

The Northern Great Plains breeding population is geographically widespread, with many birds in very remote places, especially in the U.S. and Canadian alkali lakes. 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.

Every fifth year since 1991, the USGS has coordinated a range wide International Piping Plover Census (IPPC) on both the species' wintering and breeding grounds. Results from the most recent census in 2016 are not yet published. The IPPC numbers indicate that the Northern Great Plains breeding 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 improvement, we do not consider the elements of the population recovery criteria achieved.

As the Missouri River basin emerged from drought and breeding habitat was inundated in subsequent years after 2006, the population declined (**Figure 5-1**). Combined with the numbers from Canada, 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). The 2011 breeding census count was substantially lower than the count in 2006 (over 4,500 birds in 2006 and 2,249 in 2011) (Elliott-Smith et al. 2015). It is unknown if the decrease in counts is an accurate accounting of the piping plover population numbers, or if birds were not counted due to displacement from flooding in the region that made traditional habitat unsuitable. The management activities carried out in many areas during drought conditions 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.

In the 2009 status review, the Service concluded that the Northern Great Plains breeding population remains vulnerable, especially due to management of river systems throughout the breeding range (USFWS 2009a). Many of the threats identified in the 1988 recovery plan, including those

affecting Northern Great Plains breeding population during the two-thirds of its annual cycle spent in the wintering range, remain today or have intensified.

Great Lakes Breeding 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 breeding population, which has been traditionally represented as the number of breeding pairs, has slowly increased after the completion of the recovery plan between 2003 and 2016 (**Figure 5-2**) (Cuthbert and Roche 2007; Cuthbert and Roche 2006; Westbrock et al. 2005; Stucker and Cuthbert 2004; Stucker et al. 2003; Cuthbert and Saunders 2013). The Great Lakes piping plover recovery plan documents the 2002 population at 51 breeding pairs (USFWS 2003a), and in 2016, 75 breeding pairs were estimated (Cavalieri pers. comm. 2016a). The total of 75 breeding pairs represents 50% of the current recovery goal of 150 breeding pairs for the Great Lakes breeding 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 varied, but averages about 1.7, well above the 1.5 fledglings per breeding pair recovery goal (Cavalieri pers. comm. 2016d). The total estimated population in 2016, including breeding pairs, non-breeding adults, and 2016 chicks, was approximately 330 individuals. Approximately 130 of those were 2016 chicks. However, that number is expected to have declined quickly over the winter months with the expected mortality of some hatch-year and after-hatch year adults (Cavalieri pers. comm. 2016b). Survival of fledged hatch-year individuals has been estimated at approximately 37% (Roche et al. 2008; Saunders et al. 2014). Analyses of banded piping plovers in the Great Lakes suggests that after-hatch year (adult) survival rates are declining, although management of merlin (*Falco columbarius*) predation on the breeding grounds appears to have allowed the survival rate to stabilize (Roche et al. 2010a; Saunders pers. comm. 2016). It is the productivity rate, or recruitment rate, that has continued to increase the overall population, despite considerable decreases in adult survival rates. Continued population growth will require the long-term maintenance of productivity goals concurrent with measures to sustain or improve important vital rates.

The Great Lakes annual monitoring program is an intensive survey effort with nearly daily monitoring of active breeding locations. Virtually all of the Great Lakes individuals are banded, unlike individuals from the Atlantic Coast or Northern Great Plains breeding populations. Chicks also receive bands identifying the brood to which they belong, and receive an individual band when returning to the breeding grounds after surviving their first year. Banding of Great Lakes birds began in 1993 (University of Minnesota 2017). The probability of detection of adults during the breeding season is near perfect (95-97%). Several years of population growth is evidence of the

effectiveness of the ongoing Great Lakes piping plover recovery program. However, the average annual growth of just less than 2.3% in this small population typically results in only 3 or 4 additional surviving individuals each year (Catlin pers. comm. 2016a).

A 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. The number of nesting pairs in Canada increased to four in 2008, six in 2011, and 15 in 2016 (Cavalieri pers. comm. 2016a; 2016d). These 15 nesting pairs are included in the total population of 75 breeding pairs above.

Survival rates in general for Great Lakes piping plovers have declined over 20 percentage points since 1994 (Saunders pers. comm. 2016). The estimated annual survival rates in 1994 for males in the Great Lakes breeding population was 0.878 (or almost 88%), while the survival rate for females was a bit lower at 0.87. The survival rates have fallen steadily since then, and by 2012, the survival rate was 0.667 for males and 0.650 for females (Saunders pers. comm. 2016). During this time, adult predation by merlins increased as a result of a general increase in merlin population numbers and a range expansion that began in the 1980s (Haas 2011; Cava et al. 2014). Management of merlin predation on the breeding grounds appears to have allowed the survival rate to stabilize (Roche et al. 2010a; Saunders pers. comm. 2016). Fluctuations in the number of breeding pairs between 2009 and 2016 may have been caused by weather conditions or merlin predation (Elliott-Smith et al. 2015).

In the 2009 status review, the Service concluded that the Great Lakes breeding population remains at considerable risk of extinction due to its small size, limited distribution and vulnerability to stochastic events, such as disease outbreak (USFWS 2009a). In addition, the factors that led to the piping plover's 1986 listing remain present.

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 (MBTA) (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.

Substantial population growth, from approximately 790 pairs in 1986 to an estimated 1,870 pairs in 2015, has decreased the Atlantic Coast piping plover's vulnerability to extinction since ESA listing (**Tables 5-1 and 5-2**). Thus, considerable progress has been made towards the overall goal of 2,000 breeding pairs. 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. Population growth has been tempered by geographic and temporal variability. By far, the largest net population increase between 1989 and 2015 occurred in New England (445 percent). Net growth in the southern recovery unit population was over 182 percent between 1989 and 2015, but the subpopulation recovery target has not yet been attained. Preliminary estimates indicate abundance in the New York-New Jersey recovery unit experienced a net increase of 129 percent between 1989 and 2015. However, the population declined sharply from a peak of 586 pairs in 2007 and has still not recovered, with only 411 pairs in 2015. In Eastern Canada, where increases have often been quickly eroded in subsequent years, the population posted a 25-percent decline between 1989 and 2015.

Twenty years of relatively steady population growth, driven by productivity gains, evidences the efficacy of the ongoing Atlantic Coast piping plover recovery program. However, all of the major threats identified in the 1986 ESA listing and 1996 revised recovery plan remain persistent and pervasive 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 remain or have increased since listing, reversal of gains in abundance and productivity would quickly follow diminishment of current protection efforts. In the 2009 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 2009a).

Non-breeding 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. Coastal migration stopovers by banded piping plovers from the Great Lakes region have been documented in New Jersey, Maryland, Virginia, North Carolina, South Carolina, and Georgia (Stucker et al. 2010). Migrating birds from eastern Canada have been observed in Massachusetts, New Jersey, New York, and North Carolina (Amirault et al. 2005). Piping plovers banded in the Bahamas have been sighted during

migration in nine Atlantic Coast states and provinces between Florida and Nova Scotia (Gratto-Trevor pers. comm. 2012a). In general, the distance between stopover locations and the duration of stopovers throughout the coastal migration range remain poorly understood (USFWS 2015).

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 (Noel and Chandler 2008; Cohen and Gratto-Trevor 2011; Gratto-Trevor et al. 2016; Drake et al. 2001; Noel et al. 2005; Stucker and Cuthbert 2006), even when encountering a high level of environmental disturbance (Gibson et al. 2017; 2018). 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). In the years following the 2010 Deepwater Horizon oil spill, Gibson et al. (2017) found that, in spite of significant environmental disturbance, most individuals returned to and persisted at the same wintering site.

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). In Cape Lookout National Seashore, wintering banded birds were surveyed along Shackleford Banks. Individual birds were always observed in the same general area over multiple seasons, indicating that the wintering birds are very site-specific and return to the same area in consecutive years (NPS 2003).

The majority of birds from the Canadian Prairie were observed in Texas (particularly southern Texas), while individuals from the U.S. Great Plains were more widely distributed on the Gulf Coast from Texas to Florida. Seventy-nine percent of 57 piping plovers banded in the Bahamas in 2010 were reported breeding on the Atlantic Coast; one was resighted in the Northern Great Plains (Catlin pers. comm. 2012a). Furthermore, consistent with patterns observed in other parts of the wintering range, a few individuals banded in the Great Lakes and Northern Great Plains breeding populations have been observed in the Bahamas (Gratto-Trevor pers. comm. 2012; Catlin pers. comm. 2012a). Collectively, these studies demonstrate an intermediate level of connectivity between breeding and wintering areas. Specific breeding populations will be disproportionately affected by habitat and threats occurring where they are most concentrated in the winter (USFWS 2015).

Five rangewide mid-winter IPPCs are summarized in **Table 5-3.** 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.

IPPC 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 January 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).

5.1.4. Conservation Needs of and Threats to Piping Plover

Reason for Listing

Piping plovers were listed principally because of habitat destruction and degradation, predation, and human disturbance. 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 MBTA. Other human activities, such as habitat loss and degradation, disturbance from recreational pressure, contaminants, and predation are likely responsible for continued declines. 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.

Recovery Criteria

Delisting of the three piping plover populations may be considered when the following criteria are met:

Northern Great Plains Breeding Population (USFWS 1988, 1994)

1. Increase the number of birds in the U.S. Northern Great Plains states to 2,300 pairs (Service 1994).
2. Increase the number of birds in the prairie region of Canada to 2,500 adult piping plovers (Service 1988).
3. Secure long term protection of essential breeding and wintering habitat (Service 1994).

In 2016, the Service drafted new recovery criteria for the Northern Great Plains breeding population. The new criteria are expected to be finalized in the near future.

Great Lakes Breeding 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 Breeding 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 recovery 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.

Conservation Recommendations

Nonbreeding Plovers from All Three Breeding Populations (USFWS 2012)

1. Maintain natural coastal processes that perpetuate wintering and coastal migration habitat.
2. Protect wintering and migrating piping plovers and their habitat from human disturbance.

3. Monitor nonbreeding plovers and their habitat.
4. Protect nonbreeding plovers and their habitats from contamination and degradation from oil or other chemical contaminants.
5. Assess predation as a potential limiting factor for piping plovers on wintering and migration sites.
6. Improve application or regulatory tools.
7. Develop mechanisms to provide long-term protection of nonbreeding plovers and their habitat.
8. Conduct scientific investigations to refine knowledge and inform conservation of migrating and wintering piping plovers.

Atlantic and Gulf Coast studies highlighted the importance of inlets for nonbreeding piping plovers. Almost 90% of observations of roosting piping plovers at ten coastal sites in southwest Florida were on inlet shorelines (Lott et al. 2009b). In an evaluation of 361 International Shorebird Survey sites from North Carolina to Florida (Harrington 2008), piping plovers were among seven shorebird species found more often than expected ($p = 0.0004$; Wilcoxon Scores test) at inlet versus non-inlet locations. Wintering plovers on the Atlantic Coast prefer wide beaches in the vicinity of inlets (Nicholls and Baldassarre 1990b; Wilkinson and Spinks 1994). At inlets, foraging plovers are associated with moist substrate features such as intertidal flats, algal flats, and ephemeral pools (Nicholls and Baldassarre 1990a; Wilkinson and Spinks 1994; Dinsmore et al. 1998).

Threats to Piping Plovers

The three recovery plans state that shoreline development throughout the wintering range poses a threat to all populations of piping plovers. The plans further state that beach maintenance and nourishment, inlet dredging, and artificial structures, such as jetties, groins, and revetments, could eliminate wintering areas and alter sedimentation patterns leading to the loss of nearby habitat. Unregulated motorized and pedestrian recreational use, inlet and shoreline stabilization projects, beach maintenance and nourishment, and pollution affect most winter and migration areas. Data from studies at Hilton Head, Kiawah Island, and other locations in South Carolina and Georgia demonstrate that impacts from poor winter habitat conditions can be seen the following year on the breeding grounds (Saunders et al. 2014; Gibson et al. 2016). Piping plovers wintering at areas with fewer anthropogenic disturbances had higher survival, recruitment, and population growth rates than areas with greater disturbance.

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. As discussed in more detail below, all these efforts result in loss of piping plover habitat. These threats are exacerbated by accelerating sea level rise, which increases erosion and habitat loss where existing development and hardened stabilization structures prevent the natural migration of the beach and/or barrier island. Construction 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. The shrinking extent of shoreline that supports natural coastal formation processes concentrates foraging and roosting opportunities for all shorebird species, and forces some individuals into suboptimal habitats. Thus, intra- and inter-specific competition most likely exacerbates threats from habitat loss and degradation. The 2016 draft CCS includes a table to help the reader determine the relative importance of each threat, ranked as low, medium, or high based on how much of a threat they are to the wintering population (**Table 5-4)**.

Table 5-5 lists biological opinions since 2014 within the Raleigh Field Office geographic area that have been issued for adverse impacts to piping plovers and red knots. The BOs include those for beach renourishment, sandbag revetments, and terminal groin construction, all of which are included in the Environmental Baseline for this BO. In each of these BOs, a surrogate (linear footage of shoreline) was used to express the amount or extent of anticipated incidental take.

Loss, modification, and degradation of habitat

The wide, flat, sparsely vegetated barrier beaches, spits, sandbars, and bayside flats preferred by piping plovers in the U.S. are formed and maintained by natural forces and are thus susceptible to degradation caused by development and shoreline stabilization efforts.

Development and Construction

Development and associated construction threaten the piping plover in its migration and wintering range by degrading, fragmenting, and eliminating habitat. Constructing buildings and infrastructure adjacent to the beach can eliminate roosting and loafing habitat within the development's footprint and degrade adjacent habitat by replacing sparsely vegetated dunes or back-barrier beach areas with landscaping, pools, fences, etc. In addition, bayside development can replace foraging habitat with finger canals, bulkheads, docks and lawns. High-value plover habitat becomes fragmented as lots are developed or coastal roads are built between oceanside and bayside habitats.

There are approximately 2,119 mi of sandy beaches within the U.S. continental wintering range of the piping plover (Rice 2012b). Approximately 40% (856 mi) of these sandy beaches are developed, with mainland Mississippi (80%), Florida (57%), Alabama (55%), South Carolina (51%), and North Carolina (49%) comprising the most developed coasts (Rice 2012b). Developed beaches are highly vulnerable to further habitat loss because they cannot migrate in response to sea level rise.

Rice (2012b) has identified over 900 mi (43%) of sandy beaches in the wintering range that are currently "preserved" through public ownership, ownership by non-governmental conservation organizations, or conservation easements. This means that the remaining 17% of shoreline habitat (that which is currently undeveloped but not preserved) is susceptible to future loss to development and the attendant threats from shoreline stabilization activities and sea level rise. These preserved

beaches may be subject to some erosion as they migrate in response to sea level rise or if sediment is removed from the coastal system, and they are vulnerable to recreational disturbance. However, they are the areas most likely to maintain the geomorphic characteristics of suitable piping plover habitat.

Inlet Dredging and Sand Mining

The dredging and mining of sediment from inlet complexes threatens the piping plover on its wintering grounds through habitat loss and degradation. The maintenance of navigation channels by dredging, especially deep shipping channels such as those in Alabama and Mississippi can significantly alter the natural coastal processes on inlet shorelines of nearby barrier islands, as described by Otvos (2006), Morton (2008), Otvos and Carter (2008), and Stockdon et al. (2010). Inlet shoals consist of ebb shoals, formed by wave action interacting with the ebb tidal flow, and flood shoals, formed through supply and deposition from the littoral system into the bay during flood tide. Sediment initially is deposited in the near-field flood zone, closest to the inlet entrance. A far-field zone forms through the spreading of sediment from the near-field zone farther into the bay (Carr de Betts, 1999). Cialone and Stauble (1998) describe the impacts of mining ebb shoals within inlets as a source of beach fill material at eight locations and provide a recommended monitoring protocol for future mining events; Dabees and Kraus (2008) also describe the impacts of ebb shoal mining in southwest Florida. There are very few studies on the impacts of flood shoal mining.

Forty-four percent of the tidal inlets within the U.S. wintering range of the piping plover have been or continue to be dredged, primarily for navigational purposes. States where more than two-thirds of inlets have been dredged include Alabama (three of four), Mississippi (four of six), North Carolina (16 of 20), and Texas (13 of 18), and 16 of 21 along the Florida Atlantic coast. The dredging of navigation channels or relocation of inlet channels for erosion-control purposes contributes to the cumulative effects of inlet habitat modification by removing or redistributing the local and regional sediment supply; the maintenance dredging of deep shipping channels can convert a natural inlet that normally bypasses sediment from one shoreline to the other into a sediment sink, where sediment no longer bypasses the inlet.

Among the dredged inlets identified in Rice (2012a), dredging efforts began as early as the 1800s and continue to the present, generating long-term and even permanent effects on inlet habitat; at least 11 inlets were first dredged in the 19th century, with the Cape Fear River (North Carolina) being dredged as early as 1826 and Mobile Pass (Alabama) in 1857. Dredging can occur on a schedule ranging from quarterly to every two to three years, resulting in continual perturbations and modifications to inlet and adjacent shoreline habitat. The volumes of sediment removed in the larger projects can be significant, with 2.2 million cubic yards (mcy) of sediment removed on average every 1.9 years from the Galveston Bay Entrance (Texas) and 3.6 mcy of sediment removed from Sabine Pass (Texas) on average every 1.4 years (USACE 1992).

Inlets associated with ports and other high-traffic areas typically have maintenance dredging conducted annually, if not more often. At five shallow-draft inlets (Bogue, Topsail, Carolina Beach, and Lockwoods Folly) the Corps has typically dredged the inlet on a quarterly basis, and maintained inlet crossings and connecting channels every 1-2 years (NCDENR, 2015). Local

governments have received authorization to also conduct maintenance dredging of these inlets on the same general schedule, with beach disposal during the winter work window. Inlets that are mined for Coastal Storm Damage Reduction (CSDR) projects (conducted by the Corps or local governments) are typically dredged on three-year intervals, with placement of the sand on the adjacent shoreline. Dredging may remove intertidal shoals and unvegetated sandy habitat on inlet shoulders. These types of activities are typically conducted during the winter work window to avoid impacts to nesting sea turtles, but may have significant impacts to migrating and overwintering piping plovers.

As sand sources for beach nourishment projects have become more limited, the mining of ebb tidal shoals for sediment has increased (Cialone and Stauble 1998). This is a problem because exposed ebb and flood tidal shoals and sandbars are prime roosting and foraging habitats for piping plovers. In general, such areas are only accessible by boat; and as a result, they tend to receive less human recreational use than nearby mainland beaches. Rice (2012a) found that the ebb shoal complexes of at least 20 inlets within the wintering range of the piping plover have been mined for beach fill. Ebb shoals are especially important because they act as "sand bridges" that connect beaches and islands by transporting sediment via longshore transport from one side (updrift) to the other (downdrift) side of an inlet. The mining of sediment from these shoals upsets the inlet system equilibrium and can lead to increased erosion of the adjacent inlet shorelines (Cialone and Stauble 1998). Rice (2012a) noted that this mining of material from inlet shoals for use as beach fill is not equivalent to the natural sediment bypassing that occurs at unmodified inlets for several reasons, most notably for the massive volumes involved that are "transported" virtually instantaneously instead of gradually and continuously and for the placement of the material outside of the immediate inlet vicinity, where it would naturally bypass. The mining of inlet shoals can remove massive amounts of sediment, with 1.98 mcy mined for beach fill from Longboat Pass (Florida) in 1998, 1.7 mcy from Shallotte Inlet (North Carolina) in 2001 and 1.6 mcy from Redfish Pass (Florida) in 1988 (Cialone and Stauble 1998, USACE 2004). Cialone and Stauble (1998) found that monitoring of the impacts of ebb shoal mining has been insufficient, and in one case the mining pit was only 66% recovered after five years; they conclude that the larger the volume of sediment mined from the shoals, the larger the perturbation to the system and the longer the recovery period.

Compared to ebb shoals, flood shoals have received much less attention and study, perhaps because flood shoals are often more complex (particularly where the source of sediment may be oceanic as well as riverine) and are modified by dredging of navigation channels (Carr de Betts 1999; Militello and Kraus 2001). The mined or channelized portions of these flood channels would experience greater sediment deposition as compared to the existing condition because the deeper water would reduce the speed of the current within. When examining a proposal to mine the sand from the flood shoal in Shinnecock Bay, Militello and Kraus (2001) determined that the flood shoal could take a decade or longer to regenerate.

Inlet Stabilization and Relocation

Many navigable tidal inlets along the Atlantic and Gulf coasts are stabilized with hard structures. A description of the different types of stabilization structures typically constructed at or adjacent to inlets – jetties, terminal groins, groins, seawalls, breakwaters and revetments – can be found in the

Manual for Coastal Hazard Mitigation (Herrington 2003) and in *Living by the Rules of the Sea* (Bush et al. 1996).

The adverse direct and indirect impacts of hard stabilization structures at inlets and inlet relocations can be significant. The impacts of jetties on inlet and adjacent shoreline habitat have been described by Cleary and Marden (1999), Bush et al. (1996), Wamsley and Kraus (2005), USFWS (2009a), Thomas et al. (2011), and many others. The relocation of inlets or the creation of new inlets often leads to immediate widening of the new inlet and loss of adjacent habitat, among other impacts, as described by Mason and Sorenson (1971), Masterson et al. (1973), USACE (1992), Cleary and Marden (1999), Cleary and Fitzgerald (2003), Erickson et al. (2003), Kraus et al. (2003), Wamsley and Kraus (2005), and Kraus (2007).

Rice (2012a) found that, as of 2011, an estimated 54% of 221 mainland or barrier island tidal inlets in the U.S continental wintering range of the piping plover had been modified by some form of hardened structure, dredging, relocation, mining, or artificial opening or closure. On the Atlantic Coast, 43% of the inlets have been stabilized with hard structures, whereas 37% were stabilized on the Gulf Coast. The Atlantic coast of Florida has 17 stabilized inlets adjacent to each other, extending between the St. John's River in Duval County and Norris Cut in Miami-Dade County, a distance of 341 mi. A shorebird would have to fly nearly 344 mi between unstabilized inlets along this stretch of coast.

The state with the highest proportion of natural, unmodified inlets is Georgia (74%). The highest number of adjacent unmodified, natural inlets is the 15 inlets found in Georgia between Little Tybee Slough at Little Tybee Island Nature Preserve and the entrance to Altamaha Sound at the south end of Wolf Island National Wildlife Refuge, a distance of approximately 54 mi. Another relatively long stretch of adjacent unstabilized inlets is in Louisiana, where 17 inlets between a complex of breaches on the West Belle Pass barrier headland (in Lafourche Parish) and Beach Prong (near the western boundary of the state Rockefeller Wildlife Refuge) have no stabilization structures; one of these inlets (the Freshwater Bayou Canal), however, is dredged (Rice 2012a).

Unstabilized inlets naturally migrate, reforming important habitat components over time, particularly during a period of rising sea level. Inlet stabilization with rock jetties and revetments alters the dynamics of longshore sediment transport and the natural movement and formation of inlet habitats such as shoals, unvegetated spits and flats. Once a barrier island becomes "stabilized" with hard structures at inlets, natural overwash and beach dynamics are restricted, allowing encroachment of new vegetation on the bayside that replaces the unvegetated (open) foraging and roosting habitats that plovers prefer. Rice (2012a) found that 40% (89 out of 221) of the inlets open in 2011 have been stabilized in some way, contributing to habitat loss and degradation throughout the wintering range. Accelerated erosion may compound future habitat loss, depending on the degree of sea level rise (Titus et al. 2009). Due to the complexity of impacts associated with projects such as jetties and groins, Harrington (2008) noted the need for a better understanding of potential effects of inlet-related projects, such as jetties, on bird habitats.

Relocation of tidal inlets also can cause loss and/or degradation of piping plover habitat. Although less permanent than construction of hard structures, the effects of inlet relocation can persist for years. For example, December-January surveys documented a continuing decline in wintering

plover numbers from 20 birds pre-project (2005-2006) to three birds during the 2009 - 2011 seasons on Kiawah Island (SCDNR 2011). Subsequent decline in the wintering population on Kiawah is strongly correlated with the decline in polychaete worm densities, suggesting that plovers may have emigrated to other sites as foraging opportunities in these habitats became less profitable (SCDNR 2011). At least eight inlets in the migration and wintering range have been relocated; a new inlet was cut and the old inlet was closed with fill. In other cases, inlets have been relocated without the old channels being artificially filled.

The construction of jetties, groins, seawalls and revetments at inlets leads to habitat loss and both direct and indirect impacts to adjacent shorelines. Rice (2012a) found that these structures result in long-term effects, with at least 13 inlets across six of the eight states having hard structures initially constructed in the 19th century. The cumulative effects are ongoing and increasing in intensity, with hard structures built as recently as 2015 and others proposed for the near future. With sea level rising and global climate change altering storm dynamics, pressure to modify the remaining half of sandy tidal inlets in the range is likely to increase, notwithstanding that this would be counterproductive to the climate change adaptation strategies recommended by the USFWS (2010d), CCSP (2009), Williams (2013), Pilkey and Young (2009), and others.

Invertebrate communities may also be affected by changes in the physical environment resulting from shoreline stabilization activities that alter the sediment composition or degree of exposure. For example, in 2006 on Bird Key, South Carolina, rapid habitat changes occurred within the sheltered lagoon habitat following dredge disposal activities, and piping plovers shifted to more exposed areas. Their diet also appeared to have shifted to haustoriid amphipods, based on analysis of fecal samples containing pieces of amphipod species which were also found during the invertebrate sampling at that location (SCDNR 2011).

Over the past decade or two, development of the North Carolina coast has accelerated. Of the 20 currently open inlets, 16 are modified by man in some manner (**Table 5-6**) (Rice 2016). All 16 are dredged, and 7 have hardened structures. Brown's Inlet, Bear Inlet, New Old Drum Inlet, and Ophelia Inlet are the only four that have not had some type of habitat modification.

Groins

In 2017, there are 34 groins along the North Carolina coast (Rice 2016). Groins pose an ongoing threat to piping plover beach habitat within the continental wintering range. Groins are hard structures built perpendicular to the shoreline, designed to trap sediment traveling in the littoral drift and to slow erosion on a particular stretch of beach or near an inlet. "Leaky" groins, also known as permeable or porous groins, are low-crested structures built like typical groins but which allow some fraction of the littoral drift or longshore sediment transport to pass through the groin. They have been used as terminal groins near inlets or to hold beach fill in place for longer durations. Although groins can be individual structures, they are often clustered along the shoreline in "groin fields." Because they intentionally act as barriers to longshore sand transport, groins cause downdrift erosion, which degrades and fragments sandy beach habitat for the piping plover and other wildlife. The resulting beach typically becomes scalloped in shape, thereby fragmenting plover habitat over time.

Groins and groin fields are found throughout the southeastern Atlantic and Gulf Coasts and are present at 28 of 221 sandy tidal inlets (Rice 2012a). In North Carolina, there are three currently existing terminal groins: along Oregon Inlet, at Fort Macon along Beaufort Inlet in Carteret County, and on Bald Head Island in New Hanover County. The terminal groin on Bald Head Island was installed in 2015, but the other two (Oregon Inlet and Fort Macon) were installed decades ago, and downdrift erosion has been severe at both, requiring frequent nourishment (Pietrafesa 2012; Riggs et al 2009). The Fort Macon groin is fronted by a larger structure that Rice (2016) refers to as jetty. There are two degraded groin/jetty structures in Dare County, adjacent to the old location of the Cape Hatteras lighthouse.

Although most groins were in place before the piping plover's 1986 ESA listing, new groins continue to be installed, perpetuating the threat to migrating and wintering piping plovers. As sea level rises at an accelerating rate, the threat of habitat loss, fragmentation and degradation from groins and groin fields may increase as communities and beachfront property owners seek additional ways to protect infrastructure and property.

Seawalls and Revetments

Seawalls and revetments are hard vertical structures built parallel to the beach in front of buildings, roads, and other facilities. Although they are intended to protect human infrastructure from erosion, these armoring structures often accelerate erosion by causing scouring both in front of and downdrift from the structure, which can eliminate intertidal plover foraging 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. Dugan and Hubbard (2006) found in a California study that intertidal zones were narrower and fewer in the presence of armoring, armored beaches had significantly less macrophyte wrack, and shorebirds responded with significantly lower abundance (more than three times lower) and species richness (2.3 times lower) than on adjacent unarmored beaches. As sea level rises, seawalls will prevent the coastline from moving inland, causing loss of intertidal foraging habitat (Galbraith et al. 2002; Defeo et al. 2009). Geotubes (long cylindrical bags made of high-strength permeable fabric and filled with sand) are less permanent alternatives, but they prevent overwash and thus the natural production of sparsely vegetated habitat.

Rice (2012b) found that at least 230 mi of beach habitat has been armored with hard erosion-control structures. Data were not available for all areas, so this number is a minimum estimate of the length of habitat that has been directly modified by armoring. Out of 221 inlets surveyed, 89 were stabilized with some form of hard structure, of which 24 had revetments or seawalls along their shorelines.

Although North Carolina has prohibited the use of hard erosion-control structures or armoring since 1985 (with the exception of the six terminal groins recently legislated), the "temporary" installation of sandbag revetments is allowed. As a result, the precise length of armored sandy beaches in North Carolina is unknown, but at least 350 sandbag revetments have been constructed (Rice 2012b). South Carolina also limits the installation of some types of new armoring but already has

24 mi (27% of the developed shoreline or 13% of the entire shoreline) armored with some form of shore-parallel erosion-control structure (SC DHEC 2010).

The repair of existing armoring structures and installation of new structures continues to degrade, destroy, and fragment beachfront plover habitat throughout its continental wintering range. As sea level rises at an accelerating rate, the threat of habitat loss, fragmentation and degradation from hard erosion-control structures is likely to increase as communities and property owners seek to protect their beachfront development. As coastal roads become threatened by rising sea level and increasing storm damage, additional lengths of beachfront habitat may be modified by riprap, revetments, and seawalls.

Sand Placement Projects

Sand placement projects threaten the piping plover and its habitat by altering the natural, dynamic coastal processes that create and maintain beach strand and bayside habitats, including the habitat components that piping plovers rely upon. Although specific impacts vary depending on a range of factors, so-called "soft stabilization" projects may directly degrade or destroy roosting and foraging habitat in several ways. Beach habitat may be converted to an artificial berm that is densely planted in grass, which can in turn 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 and maintains sparsely vegetated roosting habitats. The growth of vegetation resulting from impeding the natural overwash can also reduce the availability of bayside intertidal feeding habitats.

Overwash is an essential process, necessary to maintain the integrity of many barrier islands and to create new habitat (Donnelly et al. 2006). In a study on the Outer Banks of North Carolina, Smith et al. (2008) found that human "modifications to the barrier island, such as construction of barrier dune ridges, planting of stabilizing vegetation, and urban development, can curtail or even eliminate the natural, self-sustaining processes of overwash and inlet dynamics." They also found that such modifications led to island narrowing from both oceanside and bayside erosion. Lott et al. (2009b) found a strong negative correlation between ocean shoreline sand placement projects and the presence of piping and snowy plovers in the Panhandle and southwest Gulf Coast regions of Florida.

Sand placement projects threaten migration and wintering habitat of the piping plover in every state throughout the range (Rice 2012b). At least 684.8 mi (32%) of sandy beach habitat in the continental wintering range of the piping plover have received artificial sand placement via dredge disposal activities, beach nourishment or restoration, dune restoration, emergency berms, inlet bypassing, inlet closure and relocation, and road reconstruction projects, including over 91 mi in North Carolina. In most areas, sand placement projects are in developed areas or adjacent to shoreline or inlet hard stabilization structures in order to address erosion, reduce storm damages, or ameliorate sediment deficits caused by inlet dredging and stabilization activities.

Wintering and migrating piping plovers depend on the availability and abundance of macroinvertebrates as an important food item. Polychaete worms comprise the majority of the shorebird diet (Kalejta 1992; Mercier and McNeil 1994; Tsipoura and Burger 1999; Verkuil et al.

2006) and of the piping plover diet in particular (Hoopes 1993; Nicholls 1989; Zonick and Ryan 1996). The quality and quantity of the macroinvertebrate prey base is threatened by shoreline stabilization activities, including the approximately 685 mi of beaches that have received sand placement of various types. The addition of dredged sediment can temporarily affect the benthic fauna of intertidal systems. Invertebrates may be crushed or buried during project construction. Although some benthic species can burrow through a thin layer of additional sediment (38-89 cm for different species), thicker layers (i.e., >1 meter (m)) are likely to smother these sensitive benthic organisms (Greene 2002). Numerous studies of such effects indicate that the recovery of benthic fauna after beach nourishment or sediment placement projects can take anywhere from six months to two years, and possibly longer in extreme cases (Thrush et al. 1996; Peterson et al. 2000; Zajac and Whitlatch 2003; Bishop et al. 2006; Peterson et al. 2006).

Delayed recovery of the benthic prey base or changes in their communities due to physical habitat changes may affect the quality of piping plover foraging habitat. The duration of the impact can adversely affect piping plovers because of their high site fidelity. Uncertainty persists about the impacts of various projects to invertebrate communities and how these impacts affect shorebirds, particularly the piping plover.

Both the number and the size of sand projects along the Atlantic and Gulf coasts are increasing (Trembanis et al. 1999), and these projects are increasingly being chosen as a means to combat sea level rise and related beach erosion problems (Klein et al. 2001). Throughout the plover migration and wintering range, the number of sand placement events has increased every decade for which records are available, with at least 710 occurring between 1939 and 2007, and more than 75% occurring since 1980 (Trembanis et al. 1999). The cumulative volume of sand placed on East Coast beaches has risen exponentially since the 1920s (Trembanis et al. 1999). As a result, sand placement projects increasingly pose threats to plover habitat.

Invasive Vegetation

The spread of invasive plants into suitable wintering piping plover habitat is a relatively recently identified threat (USFWS 2009a). Such plants tend to reproduce and spread quickly and to exhibit dense growth habits, often outcompeting native plants. Uncontrolled invasive plants can shift habitat 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. The propensity of invasive species to spread, and their tenacity once established, make them a persistent threat that is only partially countered by increasing landowner awareness and willingness to undertake eradication activities. Many invasive species are either currently affecting or have the potential to affect coastal beaches and thus plover habitat, including beach vitex (*Vitex rotundifolia*), crowfootgrass (*Dactyloctenium aegyptium*), Australian pine (*Casuarina equisetifolia*), and Japanese sedge *(Carex kobomugi)*. Defeo et al. (2009) cite biological invasions of both plants and animals as global threats to sandy beaches, with the potential to alter the food web, nutrient cycling and invertebrate assemblages. Although the extent of the threat is uncertain, this may be due to poor survey coverage more than an absence of invasions.

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 for many other shorebirds. Because shorebird numbers are positively correlated both with wrack cover and the biomass of their invertebrate prey that feed on wrack (Tarr and Tarr 1987; Hubbard and Dugan 2003; Dugan et al. 2003), beach grooming has been shown to decrease bird numbers (Defeo et al. 2009).

Although beach cleaning and raking machines effectively remove human-made debris, they also remove accumulated wrack, topographic depressions, emergent foredunes and hummocks, and sparse vegetation nodes used by roosting and foraging piping plovers (Nordstrom 2000; Dugan and Hubbard 2010). Removal of wrack also reduces or eliminates natural sand-trapping, further destabilizing the beach. Furthermore, the sand adhering to seaweed and trapped in the cracks and crevices of wrack also is lost to the beach when the wrack is removed. Although the amount of sand lost during a single sweeping activity may be small, over a period of years this loss could be significant (Neal et al. 2007).

Accelerating sea level rise and other climate change impacts

Accelerating sea level rise poses a threat to piping plovers during the migration and wintering portions of their life cycle. As noted in the previous section, threats from sea level rise are tightly intertwined with artificial coastal stabilization activities that modify and degrade habitat. If climate change increases the frequency or magnitude of extreme temperatures, piping plover survival rates may be affected.

Numerous studies have documented accelerating rise in sea levels worldwide (Rahmstorf et al. 2007; Douglas et al. 2001 as cited in Hopkinson et al. 2008; CCSP 2009; Pilkey and Young 2009; Vermeer and Rahmstorf 2009). Potential effects of sea level rise on piping plover roosting and foraging habitats may vary regionally due to subsidence or uplift, the geological character of the coast and nearshore, and the influence of management measures such as beach nourishment, jetties, groins, and seawalls (CCSP 2009; Galbraith et al. 2002; Gutierrez et al. 2011). Gutierrez et al. (2011) found that along the Atlantic coast, the central and southern Florida coast is the most likely Atlantic portion of the wintering and migration range to experience moderate to severe erosion with sea level rise.

Inundation of piping plover habitat by rising seas could lead to permanent loss of habitat, especially if those shorelines are armored with hardened structures (Brown and McLachlan 2002; Dugan and Hubbard 2006; Defeo et al. 2009). Overwash and sand migration are impeded on the developed portions of sandy ocean beaches (Smith et al. 2008) that comprise 40% of the U.S. nonbreeding range (Rice 2012b). As the sea level rises, the ocean-facing beaches erode and attempt to migrate inland. Buildings and artificial sand dunes then prevent sand from washing back toward the lagoons (i.e., bayside), and the lagoon side becomes increasingly submerged during extreme high tides (Scavia et al. 2002). Barrier beach shorebird habitat and natural features that protect mainland developments are both diminished as a result.

Modeling by Galbraith et al. (2002) for three sea level rise scenarios at five important U.S. shorebird staging and wintering sites predicted aggregate loss of 20-70% of current intertidal foraging habitat. The most severe losses were projected at sites where the coastline is unable to move inland due to steep topography or seawalls. Although habitat losses in some areas are likely to be offset by gains in other locations, Galbraith et al. (2002) noted that time lags between these losses and the creation of replacement habitat elsewhere may have 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 subsequent productivity.

Storm Events

Storms are an integral part 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, biologists reported piping plover use of newly created habitats at Gulf Islands National Seashore in Florida within six months of overwash events that occurred during the 2004 and 2005 hurricane seasons (Nicholas pers. comm. 2005). Hurricane Katrina created a new inlet and improved habitat conditions on some areas of Dauphin Island, Alabama, but subsequent localized storms contributed to habitat loss there (LeBlanc pers. comm. 2009) and the inlet was subsequently closed with a rock dike as part of Deepwater Horizon oil spill response efforts (Rice 2012a).

Adverse effects attributed to storms alone are sometimes actually due to a combination of storms and other environmental changes or human use patterns. Storm-induced adverse effects include post-storm acceleration of human activities such as beach nourishment, sand scraping, closure of new inlets, and berm and seawall construction. Such stabilization activities can result in the loss and degradation of feeding and resting habitats. Land managers sometimes face public pressure after big storm events to plant vegetation, install sandfences, and bulldoze artificial "dunes." Storms also can cause widespread deposition of debris along beaches. Subsequent removal of this debris often requires large machinery that in turn can cause extensive disturbance and adversely affect habitat elements such as wrack. Challenges associated with management of public use can grow when storms increase access (Gibson et. al. 2009; LeBlanc pers. comm. 2009).

Some available information indicates that birds may be resilient, even during major storms, and move to unaffected areas without harm. Other reports suggest that birds may perish in or following storm events. Noel and Chandler (2005) suspected that changes in habitat caused by multiple hurricanes along the Georgia coastline altered the spatial distribution of piping plovers and may have contributed to the winter mortality of three individuals. Wilkinson and Spinks (1994) suggested that low plover numbers in South Carolina in January 1990 could have been partially influenced by effects on habitat from Hurricane Hugo the previous fall, while Johnson and Baldassarre (1988) found a redistribution of piping plovers in Alabama following Hurricane Elena in 1985.

Severe Cold Weather

Several sources suggest the potential for adverse effects of severe winter cold on survival of piping plovers. The Atlantic Coast piping plover recovery plan mentioned high mortality of coastal birds and a drop from approximately 30-40 to 15 piping plovers following an intense 1989 snowstorm along the North Carolina coast (Fussell 1990). A preliminary analysis of survival rates for Great Lakes piping plovers found that the highest variability in survival occurred in spring and correlated positively with minimum daily temperature (weighted mean based on proportion of the population wintering near five weather stations) during the preceding winter (Roche pers. comm. 2010; 2012). Catlin (pers. comm. 2012b) reported that the average mass of ten piping plovers captured in Georgia during unusually cold weather in December 2010 was 5.7 grams (g) less than the average for nine birds captured in October of the same year (46.6 g and 52.4 g, respectively; $p = 0.003$).

Disturbance from recreation activities

Increasing human disturbance is a major threat to piping plovers in their coastal migration and wintering range (USFWS 2009a). 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). Nicholls and Baldassarre (1990a) found less people and off-road vehicles at sites where nonbreeding piping plovers were present than at sites without piping plovers. Pfister et al. (1992) and Gibson et al. (2018) implicate anthropogenic disturbance as a factor in the long-term decline of migrating shorebirds at staging areas and overwintering areas. Disturbance can cause shorebirds to spend less time roosting or foraging and more time in alert postures or fleeing from the disturbances (Burger 1991; 1994; Elliott and Teas 1996; Lafferty 2001a, 2001b; Thomas et al. 2003). 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 breeding and nonbreeding shorebirds react to dogs from farther distances than people (Lafferty 2001a, 2001b; Lord et al. 2001; Thomas et al. 2003). Off-road vehicles can disrupt piping plover's normal behavior patterns. The density of off-road vehicles negatively correlated with abundance of piping plovers on the ocean beach in Texas (Zonick 2000). Cohen et al. (2008) found that radio-tagged wintering 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 was allowed. Ninety-six percent of piping plover detections occurred on the south side of the inlet even though it was more than four times farther away from foraging sites, prompting a recommendation that controlled management experiments be conducted to determine if recreational disturbance drives roost site selection (Cohen et al. 2008).

Recreational activities, especially off-road vehicles, may degrade piping plover habitat. Tires that crush wrack into the sand render it unavailable as a roosting habitat or foraging substrate (Goldin 1993; Hoopes 1993). Off-road vehicles significantly lessened densities of invertebrates on intertidal flats on the Cape Cod National Seashore in Massachusetts (Wheeler 1979).

Various local and regional examples also illustrate threats from recreation. On a 12-km stretch of Mustang Island in Texas, Foster et al. (2009) observed a 25% decline in piping plover abundance

and a simultaneous five-fold increase in human use over a 29-year study period, 1979 – 2007. This trend was marginally significant, but declines in two other plover species were significant; declining shorebird abundance was attributed to a combination of human disturbance and overall declines in shorebird populations (Foster et al. 2009). In South Carolina, almost half of sites with five or more piping plovers had ten or more people present during surveys conducted in 2007-2008 and more than 60% allow dogs (Maddock and Bimbi unpubl. data). Zdravkovic and Durkin (2011) noted disturbance to piping plovers in Texas from kite-boarding, windsurfing, and horseback riding.

LeDee et al. (2010a) surveyed land managers of designated critical habitat sites across seven southern states and documented the extent of beach access and recreation. All but four of the 43 reporting sites owned or managed by federal, state, and local governmental agencies or by non-governmental organizations allowed public beach access year-round (88% of the sites). At the sites allowing public access, 62% of site managers reported more than 10,000 visitors during September-March, and 31% reported more than 100,000 visitors in this period. However, more than 80% of the sites allowing public access did not allow vehicles on the beach and half did not allow dogs during the winter season.

Oil spills

Piping plovers may accumulate contaminants from point and non-point sources at migratory and wintering sites. Depending on the type and degree of contact, contaminants can have lethal and sub-lethal effects on birds, including behavioral impairment, deformities, and impaired reproduction (Rand and Petrocelli 1985; Gilbertson et al. 1991; Hoffman et al. 1996). Contaminants have both the potential to cause direct toxicity to individual birds and to negatively impact their invertebrate prey base (Chapman 1984; Rattner and Ackerson 2008). Piping plovers' extensive use of the intertidal zone puts them in constant contact with coastal habitats likely to be contaminated by water-borne spills. Negative impacts can also occur during rehabilitation of oiled birds. Frink et al. (1996) describe how standard treatment protocols were modified to reflect the extreme susceptibility of piping plovers to handling and other stressors.

Following the Ixtoc spill, which began on June 3, 1979 off the coast of Mexico, approximately 350 metric tons of oil accumulated on South Texas barrier beaches, resulting in a 79% decrease in the total number of infaunal organisms on contaminated portions of the beach (Kindinger 1981; Tunnell et al. 1982). Shorebirds avoided the intertidal area of the beach, occupying the backshore or moving to estuarine habitats when most of the beach was coated (Chapman 1984). Chapman (1984) surmised that the decline in infauna probably contributed to the observed shifts in habitats used. His observations indicated that all the shorebirds, including piping plovers, avoided the contaminated sediments and concentrated in oil-free areas.

According to government estimates, the 2010 Deepwater Horizon Mississippi Canyon Well #252 oil spill discharged more than 200 million gallons of oil into the Gulf of Mexico (U.S. Government 2010). Containment activities, recovery of oil-water mix, and controlled burning removed some oil, but additional impacts to natural resources may have been caused by the 1.84 million gallons of dispersant that were applied to the spill (U.S. Government 2010). At the end of July 2010, approximately 625 mi of Gulf of Mexico shoreline was oiled.

Efforts to prevent shoreline oiling and cleanup response activities can disturb piping plovers and their habitat. Although most piping plovers were on their breeding grounds in May, June, and early July when the Deepwater well was discharging oil, oil was still washing onto Gulf beaches when the plovers began arriving back on the Gulf in mid-July. Ninety percent of piping plovers detected during the prior four years of surveys in Louisiana were in the Deepwater Horizon oil spill impact zone, and Louisiana's Department of Wildlife and Fisheries reported significant disturbance to birds and their habitat from response activities. Surface oil collection methods in these areas involved rakes, shovels, boats, all-terrain-vehicles, mechanical raking, chain raking, and surface sifters. Sub-surface collection methods from some beaches and vegetated coastlines involved auguring and digging pits/trenches using various beach-cleaning machines, excavators, track hoes, and wheeled/tracked vehicles. Responders deployed barriers to oil movement along beaches and vegetated coastlines. Using boats, pumps, walk ways, and hoses, responders flushed oil from vegetated coastlines. Front-end loaders facilitated oil washing from beaches by surf action. In some segments, responders modified habitat features to prevent or reduce the impacts of oiling. Potential long-term adverse effects stem from the construction of sand berms and closing of at least 32 inlets (Rice 2012a). A study by Gibson et al. (2017) found that piping plover demographics did not appear to be negatively influenced by the magnitude of oil observed in impacted areas. Also, piping plovers that were observed to be oiled did not appear to have lower survival probabilities following the oil spill relative to non-oiled individuals from the same winter population.

Subtler but cumulatively damaging sources of oil and other contaminants are leaking vessels, offshore oil rigs and undersea pipelines in the Gulf of Mexico, pipelines buried under the bay bottoms, and onshore facilities such as petroleum refineries and petrochemical plants. In Louisiana, about 2,500-3,000 oil spills are reported in the Gulf region each year, ranging in size from very small to thousands of barrels (Carver pers. comm. 2011). The oil from these smaller leaks and seeps, if they occur far enough from land, will tend to wash ashore as tar balls.

Pesticides and Other Contaminants

A piping plover was found among dead shorebirds discovered on a sandbar near Marco Island, Florida following the county's aerial application of the organophosphate pesticide Fenthion for mosquito control in 1997 (Pittman 2001; Williams 2001). Subsequent to further investigations of bird mortalities associated with pesticide applications and to a lawsuit being filed against the Environmental Protection Agency in 2002, the manufacturer withdrew Fenthion from the market, and Environmental Protection Agency banned all use after November 30, 2004 (American Bird Conservancy 2007). Absent identification of contaminated substrates or observation of direct mortality of shorebirds on a site used by migrating and wintering piping plovers, detection of contaminants threats is most likely to occur through analysis of unhatched eggs. Contaminants in eggs can originate from any point in the bird's annual cycle, and considerable effort may be required to ascertain where in the annual cycle exposure occurred (see, for example, Dickerson et al. 2011 characterizing contaminant exposure of mountain plovers).

There has been limited opportunistic testing of piping plover eggs. Polychlorinated biphenol (PCB) concentrations in several composites of Great Lakes piping plover eggs tested in the 1990s had potential to cause reproductive harm. Analysis of prey available to piping plovers at representative Michigan breeding sites indicated that breeding areas along the upper Great Lakes region were not

likely the major source of contaminants to this population (Best pers. comm. 1999 in USFWS 2003a). Relatively high levels of PCB, dichloro diphenyl dichloroethylene (DDE), and polybrominated diphenyl ether (PBDE) were detected in one of two clutches of Ontario piping plover eggs analyzed in 2009 (Cavalieri pers. comm. 2011). Results of opportunistic egg analyses to date from Atlantic Coast piping plovers did not warrant follow-up investigation (Mierzykowski 2009; 2010; 2012; Mierzykowski pers. comm. 2012). No recent testing has been conducted for contaminants in the Northern Great Plains piping plover population.

Predation

The extent of predation on migrating or wintering piping plovers remains largely unknown and is difficult to document. Avian and mammalian predators are common throughout the species' wintering range. Human activities affect the types, numbers, and activity patterns of some predators, thereby exacerbating natural predation on breeding piping plovers (USFWS 1996). One incident involving a cat observed stalking piping plovers was reported in Texas (NY Times 2007). It has been estimated that free-roaming cats kill over one billion birds every year in the U.S., representing one of the largest single sources of human-influenced mortality for small native wildlife (Sax and Gaines 2008, Loss et al. 2012).

Predatory birds, including peregrine falcons (*F. peregrinus)*, merlin, and harriers, are present in the nonbreeding range. Newstead (pers. comm. 2012b) reported two cases of suspected avian depredation of piping plovers in a Texas telemetry study, but he also noted that red tide may have compromised the health of these plovers. It has been noted, however, that the behavioral response of crouching when in the presence of avian predators may minimize avian predation on piping plovers (Morrier and McNeil 1991; Drake 1999a; Drake et al. 2001). Drake (1999a) theorized that this piping plover behavior enhances concealment associated with roosting in depressions and debris in Texas.

Nonbreeding piping plovers may reap some collateral benefits from predator management conducted for the primary benefit of other species. Florida Keys Refuges National Wildlife Refuge (USFWS 2011a), for example, released a draft integrated predator management plan that targets predators, including cats, for the benefit of native fauna and flora. Other predator control programs are ongoing in North Carolina, South Carolina, Florida, and Texas beach ecosystems (USFWS 2009a).

Military operations

Five of the eleven coastal military bases located in the U.S. continental range of nonbreeding piping plovers have consulted with the USFWS about potential effects of military activities on plovers and their habitat (USFWS 2009a; USFWS 2010b). Formal consultation under section 7 of the ESA with Camp Lejeune, North Carolina in 2002 provided for year-round piping plover surveys, but restrictions on activities on Onslow Beach only pertain to the plover breeding season (Hammond pers. comm. 2012). Informal consultations with three Florida bases (Naval Station Mayport, Eglin Air Force Base, and Tyndall Air Force Base) addressed training activities that included beach exercises and occasional use of motorized equipment on beaches and bayside habitats. Eglin Air Force Base conducts twice-monthly surveys for piping plovers, and habitats consistently used by

piping plovers are posted with avoidance requirements to minimize direct disturbance from troop activities. Operations at Tyndall Air Force Base and Naval Station Mayport were determined to occur outside optimal piping plover habitats. A 2001 consultation with the Navy for one-time training operations on Peveto Beach in Louisiana concluded informally (USFWS 2010b). Current threats to wintering and migrating piping plovers posed by military activities appear minimal.

Disease

No instances of disease have been documented in piping plovers outside the breeding range. The 2009 5-Year Review concluded that West Nile virus and avian influenza remain minor threats to piping plovers on their wintering and migration grounds.

Modeling to determine average annual true survival and site fidelity

Researchers at Virginia Polytechnic Institute and State University (Virginia Tech) have developed a demographic model incorporating observations of marked individuals within a study area with out-of-area observations of the same individuals throughout the species' breeding and nonbreeding ranges. This model can be used to estimate true survival and site fidelity of piping plovers (Gibson et al. 2018). The model can be used to estimate multiple seasonal and annual demographic processes based on individuals wintering at specific sites from all three breeding populations. In Gibson et al. (2018), the model was used to derive true survival at wintering sites in Georgia, South Carolina, and North Carolina, including Rich Inlet and New Topsail Inlet (from 2010 to 2016).

In order to compare survival and site fidelity rates between sites impacted by shoreline stabilization projects and sites not impacted, birds were trapped and banded by Gibson et al. (2018) at several locations in Georgia and South Carolina. Banded birds have been re-sighted on both the breeding and wintering grounds for five or six years. These sites had varying degrees of modification, from unmodified to highly disturbed. The sites in South Carolina are Hilton Head Island (terminal groin and beach nourishment), Kiawah Island East (inlet relocation)/Seabrook Island (inlet relocation), Harbor Island, Deveaux Banks, while the Georgia sites are Little Saint Simons Island and Cumberland Island. Hilton Head Island is a highly disturbed area due to multiple beach renourishment projects within a short timeframe, construction of a terminal groin, and high recreational use; Kiawah and Seabrook are considered to be moderately disturbed by inlet relocation projects. The southeast end of Harbor Island and Deveaux Banks sites are considered low disturbance areas, with relatively little man-made modification, and Little Saint Simons Island and Cumberland Island are considered unmodified, but have a certain level of ongoing disturbance from recreational use (Bimbi, pers. comm. 2016; Virginia Tech 2013; 2014; 2015). In North Carolina, survey data collected at Rich Inlet and New Topsail Inlet from 2010 to 2016 were also incorporated into the model. Plover observation data from outside of the study area from 2012 to 2016 were used to elucidate true survival and site fidelity, allowed by several intense ongoing research projects and monitoring efforts throughout the species' nonbreeding and breeding ranges (Gibson et al. 2018). True survival and site fidelity rates for the eight sites are shown in **Table 5-7.**

Pre- and post-monitoring of the east end of Kiawah Island in South Carolina, required under a biological opinion, documented a decline in the local piping plover winter population and linked the decline of bird numbers to the decline and shift of invertebrate populations at a key site. This local

population remains very low and new recruits are not selecting this site, suggesting that shoreline stabilization projects can have lasting impacts on coastal migration and winter habitat. Post-project monitoring for the Hilton Head renourishment and groin installation project and pre-project monitoring for the Captain Sam's Inlet (located between Seabrook and Kiawah Islands) relocation documented similar declines in piping plover use (Virginia Tech 2013; SCDNR 2011).

Further, there is a correlation between level of disturbance and body weight at the Georgia and South Carolina sites. Birds at the highly disturbed sites weighed 3.74 grams (7%) less on average than birds at the low disturbance sites (Gibson et al. 2018). 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.

Conservation Efforts

The 2012 CCS (USFWS 2012; 2015) synthesizes conservation needs across the shared coastal migration and wintering ranges of the three piping plover populations, and presents recommended conservation actions for protection of nonbreeding piping plovers that are contained in the approved recovery plans (USFWS 1988b, 1996, 2003) and recommendations for future action in the 2009 5-Year Review (USFWS 2009a). Implementation of actions described in the CCS will support attainment of relevant reclassification and delisting criteria (USFWS 1996; 2003).

Conservation efforts on behalf of piping plovers in their non-breeding range have increased since the species listing and further accelerated since the early 2000s. Diverse conservation tools are selectively used to address protection needs across federal, state, municipal, and private land ownership.

5.1.5. Summary of Piping Plover Status

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 in the Action Area may include individuals from all three breeding populations. 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.

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.

It appears that the Northern Great Plains breeding population (including Canada) declined from 1991 through 2001, increased dramatically in 2006, and then declined again in 2011 (Elliott-Smith et al. 2015).

The Great Lakes population has shown significant growth, from approximately 17 pairs at the time of listing in 1986, to 75 pairs in 2016 (Cavalieri pers. comm. 2016a). The total of 75 breeding pairs represents 50% of the current recovery goal of 150 breeding pairs for the Great Lakes population.

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. 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. 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.

A review of threats to piping plovers and their habitat in their migration and wintering range shows a continuing loss and degradation of habitat due to sand placement projects, inlet stabilization, sand mining, groins, seawalls and revetments, dredging of canal subdivisions, invasive vegetation, and wrack removal. Shoreline stabilization projects can have lasting impacts on coastal migration and winter habitat. 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. This cumulative habitat loss is, by itself, of major threat to piping plovers, as well as the many other shorebird species competing with them for foraging resources and roosting habitats in their nonbreeding range. However, artificial shoreline stabilization also impedes the processes by which coastal habitats adapt to storms and accelerating sea level rise, thus setting the stage for compounding future losses. Furthermore, inadequate management of increasing numbers of beach recreationists reduces the functional suitability of coastal migration and wintering habitat and increases pressure on piping plovers and other shorebirds depending upon a shrinking habitat base. Experience during the Deepwater Horizon oil spill illustrates how, in addition to the direct threat of contamination, spill response activities can result in short- and long-term effects on habitat and disturb piping plovers and other shorebirds. If climate change increases the frequency and magnitude of severe weather events, this may pose an additional threat.

5.1.6. Tables and Figures for Status of Piping Plover

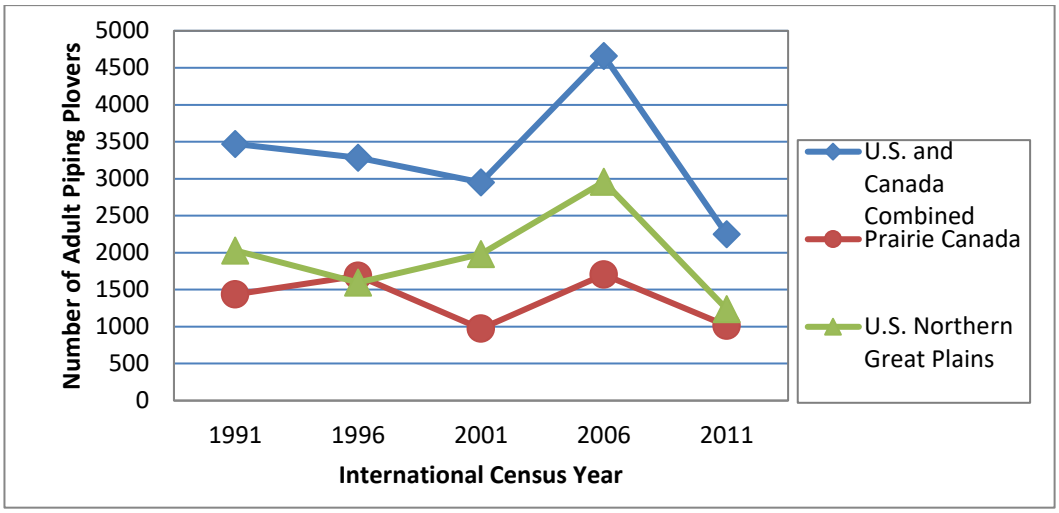


Figure 5-1. The number of adults reported for the U.S. and Canada Northern Great Plains breeding population during the International Censuses from 1991 to 2011. Data from Elliott-Smith et al. 2009, Elliott-Smith et al. 2015, Ferland and Haig 2002, Haig and Plissner 1993, Plissner and Haig 2000.

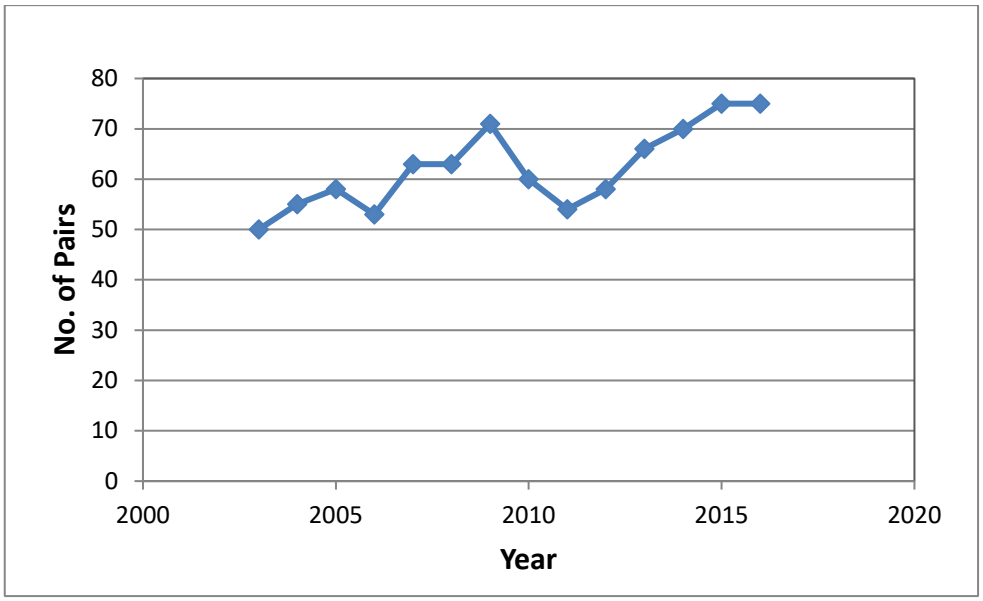


Figure 5-2. Annual Breeding Pair Estimates for Great Lakes Piping Plovers (2003-2016). Data from Cuthbert and Saunders 2013, Cavalieri pers. comm. 2016a; 2016c.

Table 5-1. Estimated abundance of Atlantic Coast piping plovers, 1986 to 2000. Unpublished data from the Service (2016).

State or Recovery Unit	**Number of pairs /year**														
	1986	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Maine	15	12	20	16	17	18	24	32	35	40	60	47	60	56	50
New Hampshire												5	5	6	6
Massachusetts	139	126	134	137	140	160	213	289	352	441	454	483	495	501	496
Rhode Island	10	17	19	19	28	26	20	31	32	40	50	51	46	39	49
Connecticut	20	24	27	34	43	36	40	24	30	31	26	26	21	22	22
New York	106	135	172	191	197	191	187	193	209	249	256	256	245	243	289
New Jersey	102	93	105	128	126	126	134	127	124	132	127	115	93	107	112
Delaware	8	7	3	3	6	5	2	2	4	5	6	4	6	4	3
Maryland	17	23	25	20	14	17	24	19	32	44	61	60	56	58	60
Virginia	100	100	103	121	125	131	97	106	96	118	87	88	95	89	96
North Carolina	30	30	40	55	55	40	49	53	54	50	35	52	46	31	24
South Carolina	3		0		1	1		1			0				
U.S. Total	550	567	648	724	752	751	790	877	968	1150	1162	1187	1168	1156	1207
Eastern Canada	240	223	238	233	230	252	223	223	194	200	202	199	211	236	230
Atlantic Coast Total	790	790	886	957	982	1003	1013	1100	1162	1350	1364	1386	1379	1392	1437

Table 5-2. Estimated abundance of Atlantic Coast piping plovers, 2001 to 2014, with Preliminary data from 2015. Unpublished data from the Service (2016). *Numbers in parentheses are preliminary estimates, subject to revision.

State or Recovery Unit	**Number of pairs /year**														
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015***
Maine	55	66	61	55	49	40	35	24	27	30	33	42	44	50	62
New Hampshire	7	7	7	4	3	3	3	3	5	4	4	6	7	6	8
Massachusetts	495	538	511	488	467	482	558	566	593	591	656	676	666	663	687
Rhode Island	52	58	71	70	69	72	73	77	84	85	86	90	92	91	99
Connecticut	32	31	37	40	34	37	36	41	44	43	52	51	45	51	62
New York	309	369	386	384	374	422	457	443	437	390	318	342	289	268	(303)
New Jersey	122	138	144	135	111	116	129	111	105	108	111	121	108	92	108
Delaware	6	6	6	7	8	9	9	10	10	9	8	7	6	6	6
Maryland	60	60	59	66	63	64	64	49	45	44	36	41	45	38	36
Virginia	119	120	114	152	192	202	199	208	193	192	188	259	251	245	256
North Carolina	23	23	24	20	37	46	61	64	54	61	62	70	56	65	64
South Carolina	0						0								
U.S. Total	1280	1416	1420	1421	1407	1493	1624	1596	1597	1557	1554	1705	1609	1593	(1691)
Eastern Canada	250	274	256	237	217	256	266	253	252	225	209	179	184	186	179
Atlantic Coast Total	1530	1690	1676	1658	1624	1749	1890	1849	1849	1782	1763	1884	1793	1779	(1870)

Table 5-3. Results of the 1991, 1996, 2001, 2006, and 2011 International Piping Plover Winter Censuses (Haig and Plissner 1993; Plissner and Haig 2000; Ferland and Haig 2002; Haig et al. 2005; Elliott-Smith et al. 2009; Elliott-Smith et al. 2015).

Location	**1991**	**1996**	**2001**	**2006**	**2011**
Virginia	not surveyed (ns)	ns	ns	1	1
North Carolina	**20**	**50**	**87**	**84**	**43**
South Carolina	51	78	78	100	86
Georgia	37	124	111	212	63
Florida	551	375	416	454	306
-Atlantic	*70*	*31*	*111*	*133*	*83*
-Gulf	*481*	*344*	*305*	*321*	*223*
Alabama	12	31	30	29	38
Mississippi	59	27	18	78	88
Louisiana	750	398	511	226	86
Texas	1,904	1,333	1,042	2,090	2,145
Puerto Rico	0	0	6	2	2
U.S. Total	**3,384**	**2,416**	**2,299**	**3,357**	**2,858**
Mexico	27	16	ns	76	30
Bahamas	29	17	35	417	1,066
Cuba	11	66	55	89	19
Other Caribbean Islands	0	0	0	28	ns
GRAND TOTAL	**3,451**	**2,515**	**2,389**	**3,884**	**3,973**
Percent of Total International Piping Plover Breeding Census	62.9%	42.4%	40.2%	48.2%	69.4%

Table 5-4. Piping plover wintering grounds threats matrix. The threats are ranked according to their overall potential impact on the population. The Service acknowledges there are differences in relative importance of each threat at a regional scale; the chart represents an overall ranking on the wintering population based on the amount of information currently known, the amount of habitat affected, and the difficulty in ameliorating the threat.

	Threat Level			
	Low	**Medium**	**High**	**Unknown**
Loss, modification, and degradation of habitat				
Development and construction			X	
Dredging and sand mining			X	
Inlet stabilization and relocation			X	
Groins			X	
Seawalls and revetments			X	
Sand placement projects		X[1]		
Loss of macroinvertebrate prey base due to shoreline stabilization		X		
Invasive vegetation			X[2]	
Wrack removal and beach cleaning		X		
Accelerating sea level rise and other climate change impacts			X	
Weather events				
Storm events	X			
Severe cold weather	X			
Disturbance from recreational activities		X[3]		
Oil spills and other contaminants				
Oil Spills		X		
Pesticides and Other Contaminants	X			
Energy development				
Land-based oil and gas exploration and development	X			
Wind turbines				X
Predation	X			
Military operations	X			
Disease	X			

[1] The threat level of sand placement projects varies among sites and projects. In areas where the loss of critical habitat is imminent due to sea level rise and subsidence, well-designed, infrequent sand placement projects can provide overall benefits to critical habitat once the benthic fauna recovers and natural processes are allowed to reshape the beach and dune system.
[2] The impact and extent of invasive vegetation varies across the range. Regionally, invasive plant growth can have a large impact on habitat availability, while in other parts of the wintering range, invasive species are not an issue.
[3] At some sites recreational disturbance would be considered a higher level of threat if the disturbance in essence makes the site unavailable or marginally useful to the plovers.

Table 5-5. Biological opinions issued since 2014 within the Raleigh Field Office geographic area, for adverse impacts to piping plovers and red knots.

Opinions	**Piping Plover Critical Habitat**	**Piping Plover and Red Knot Habitat**
Fiscal Year 2014: 1 BO	n/a	12,600 lf (2.4 mi)
Fiscal Year 2015: 5 BOs	Approx. 33.49 acres, 2,200 lf	70,268 lf (13.3 mi)
Fiscal Year 2016: 8 BOs	9,696 lf (1.83 mi)	231,437 lf (43.83 mi)
Fiscal Year 2017: 2 BOs including Statewide Programmatic	Unknown amount discussed in Statewide Programmatic BO	27,650 lf (5.24 mi) **Plus up to** 25 mi/62.5 mi per year
Fiscal Year 2018 (to date): 2 BOs	n/a	75,800 lf (14.36 mi)
Total: 18 BOs	**11,896 lf (2.25 mi), approx. 33.49 acres, plus unknown amount from utilization of Statewide Programmatic BO.**	**417,755 lf** **(79.12 mi)** **Plus up to** **25 mi/62.5 mi per year**

Table 5-6. Open tidal inlets from north to south along the North Carolina coast in 2015 with actual (X) and proposed (P) habitat modification(s) at each. Note that an X in the Jetties column indicates one jetty is present and a D indicates two (dual) jetties. Table from Rice (2016).

Order	Inlet	Type of Habitat Modification							
		Artificially created	Jetties	Terminal groins / groin field	Seawalls / revetment	Breakwaters	Dredging	Relocation of channel or	Mined for beach fill
1	Oregon Inlet1			X			X		X
2	Hatteras Inlet						X		
3	Ocracoke Inlet						X		
4	New Old Drum Inlet								
5	Ophelia Inlet								
6	Barden Inlet					X	X		X
7	Beaufort Inlet		X	X			X		
8	Bogue Inlet				X		X	X	X
9	Bear Inlet								
10	Brown's Inlet								
11	New River Inlet				X		X	X	X
12	New Topsail Inlet						X		X
13	Rich Inlet			P			X	P	X
14	Mason Inlet	X					X	X	X
15	Masonboro Inlet	X	D				X	X	X
16	Carolina Beach Inlet	X					X		X
17	Cape Fear River			X			X		
18	Lockwoods Folly Inlet			P			X		
19	Shallotte Inlet			P			X		X
20	Tubbs Inlet	X			X		X	X	

1 – The NCDOT mined ~33,000 cy of sediment from within Oregon Inlet to fill a scour hole adjacent to the Herbert C. Bonner Bridge across the inlet in December 2013, which had destabilized the bridge and led to its emergency closure.

Table 5-7. Average annual piping plover true survival and site fidelity rates at eight inlets from North Carolina to Georgia (Gibson et al. 2018).

Study Region	Relative Disturbance	True Survival (± SD)	Site Fidelity (± SD)
New Topsail Inlet	High	0.66 ± 0.08	0.74 ± 0.08
Rich Inlet	Low	0.92 ± 0.08	0.80 ± 0.08
Kiawah and Seabrook Islands	High	0.55 ± 0.09	0.91 ± 0.06
Deveaux Bank	Low	0.50 ± 0.07	0.85 ± 0.07
Harbor Island	Low	0.77 ± 0.06	0.91 ± 0.04
Hilton Head Island	High	0.62 ± 0.07	0.81 ± 0.07
Little Saint Simons Island	Low	0.67 ± 0.04	0.91 ± 0.03
Cumberland Island National Seashore	Low	0.68 ± 0.05	0.73 ± 0.06

5.2. Environmental Baseline for Piping Plover

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the piping plover, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

5.2.1. Action Area Numbers, Reproduction, and Distribution of Piping Plover

Although there are some efforts to post breeding areas, there do not appear to be any organized management actions to protect wintering and migrating piping plovers in the Action Area. Survey efforts conducted by NCWRC, third parties (Audubon North Carolina), or by permittees provide information on the piping plover populations that are present in the critical habitat unit.

Breeding Piping Plovers

The NCWRC conducted coast-wide surveys for breeding piping plovers in North Carolina between June 1 and June 9 of 2010 through 2018. Breeding piping plovers were documented on Topsail Beach (www.ncpaws.org, accessed August 20, 2018), including one nest at North Topsail Beach in 2018, from which four chicks fledged, and a nest on the south end of Topsail Beach which fledged one chick (Jennings pers. comm. 2018). Data provided by the BA indicate that one breeding pair was also seen in the vicinity of the project footprint in 2017. Data from NCWRC's database indicate that one breeding pair was documented at New Topsail Inlet in 2010, 2011, 2013, 2017, and 2018, but 2018 is the first year for a successful nest during this time. A nest with two eggs was documented on Topsail Beach in 2016, but no chicks fledged (Suiter pers. comm. 2016, Schweitzer 2016). It is unclear whether the nesting pair includes the same individuals from year to year or different individuals. On Figure Eight Island at Rich Inlet, at least one breeding pair of piping plovers has been documented for many of the past few years. During the summers of 2014, 2015, and 2016, a piping plover nest was recorded on the

north end of Figure Eight Island. One chick fledged in the summer of 2016 (Schweitzer pers. comm. 2016). Only eight chicks fledged in the state of North Carolina in 2016, including two (2) at Cape Hatteras National Seashore and five (5) at Cape Lookout National Seashore (Schweitzer 2016). The IPPC breeding survey documented no piping plovers on Figure Eight Island and two breeding pairs (five adults) on Lea-Hutaff Island in 2001 (Ferland and Haig 2002), and 11 breeding piping plover adults (including five breeding pairs) on Lea/Hutaff Island in 2006 (Elliott-Smith et al. 2009).

South Carolina has historically been the most southern Atlantic state where piping plover nesting occurs. Nesting habitat for piping plovers is being lost incrementally in the Carolinas. In recent years, no piping plover nests have been observed in South Carolina. The nests on Figure Eight Island at Rich Inlet currently represent the southernmost documented. Because of the relatively undisturbed nature of Figure Eight Island at Rich Inlet, the area provides one of the best remaining nesting habitats in North Carolina, outside of the National Seashores.

Nonbreeding Piping Plovers

Surveys by multiple groups have documented many banded piping plovers during migration and winter within the Action Area. The migrant population is larger than the winter population. Reports from the National Seashores, and unpublished data from NCWRC's PAWS database (www.ncpaws.org) and Audubon North Carolina provide banded piping plover data for most coastal areas of North Carolina. The majority of banded piping plovers are recorded on Cape Hatteras and Cape Lookout National Seashores, and the islands and inlet complexes from Cape Lookout south to Masonboro Island. Only a few banded birds have been recorded in North Carolina south of Carolina Beach Inlet, in part because there are fewer records due to development of these areas, and also focus by the bird community on areas north. Banded piping plovers from all three breeding populations have been recorded on the National Seashores and south to Masonboro Inlet. This region of North Carolina, from Cape Lookout to Masonboro Inlet, is extremely important to the survival and recovery of the piping plover, particularly the Great Lakes piping plover.

Piping plovers that winter at sites (meaning they spend the majority of their nonbreeding season at one location) can arrive at their winter site as early as August and depart as late as April (Maddock et al. 2009). However, because plovers are also migrating through North Carolina from late summer through early winter and again from late winter through early spring the best winter population estimate is determined in December and/or January. Results of a band re-sighting analysis for birds documented at sites in South Carolina showed zero immigration or emigration during the months of December and January (Cohen, pers. comm. 2009). Therefore, the Service determines the local winter population by using the single highest count of birds observed during surveys conducted between December 1 and January 31.

Between 2007 and 2016, Audubon North Carolina identified approximately 122 individually-banded piping plovers along the North Carolina coast from Topsail Island south to Masonboro Island (Addison pers. comm. 2016). This area encompasses four inlets and five islands: Topsail Island, (New) Topsail Inlet, Lea-Hutaff Island, Rich Inlet, Figure Eight Island, Mason Inlet, Wrightsville Beach, Masonboro Inlet, and Masonboro Island. Seventy-nine of these banded

plovers are from the Great Lakes breeding population, 28 from the Atlantic Coast breeding population, and nine are from the Northern Great Plains population. Only six are from an unidentified population.

The number or percentage of banded birds in each of the three populations depends on active banding projects. Virtually all of the Great Lakes individuals are banded, unlike individuals from the Atlantic Coast or Northern Great Plains breeding populations; the larger Atlantic Coast and Northern Great Plain populations only have banding projects at a few sites across their broad breeding ranges (Gratto-Trevor et al. 2012). Banding of the Great Lakes population began in 1993. Adults are banded with aluminum Service bands and three-color bands to uniquely identify the individual. Chicks are banded with aluminum Service bands and a single color band to identify the hatch site (University of Minnesota 2017). Most of the unbanded birds are expected to be from the Atlantic Coast population.

Data from Audubon North Carolina and NCWRC indicate that as many as 12 piping plovers (banded and unbanded) were documented in New Topsail Inlet on March 17, 2011, and as many as 15 on March 25, 2011. As many as 18 were documented on one day in the winter of 2008/2009. In 2016, the IPPC surveys on February 1 documented 11 piping plovers, three of which were banded. **Table 5-8** provides the highest number of observed piping plovers on a single date between December 1 and January 31 at New Topsail and Rich Inlets, from 2006-2016 (Addison pers. comm. 2016; www.ncpaws.org).

Table 5-9 provides the total numbers of banded piping plovers at New Topsail Inlet from the three populations. As many as 15 individually banded piping plovers utilized the inlet area annually between 2008 and 2010. This number dropped to five in 2010/2011 (the same year as the first of the most recent dredging projects), but increased to between seven and ten individuals from 2011/2012 to 2015/2016. In the winter of 2016/2017, only four individuals were recorded during the migration and wintering season (three of those during the winter months of December and January).

Table 5-10 provides the total numbers of banded piping plovers at Rich Inlet from the three populations. Unpublished data from NCWRC's PAWS database (www.ncpaws.org) and others indicate that at least 54 banded piping plovers have been documented on either side of Rich Inlet or on Figure Eight Island since 2006, including at least 32 individuals from the endangered Great Lakes breeding population. The area has been monitored or surveyed by several different parties, and large numbers of banded and unbanded piping plovers have been observed throughout the migration and wintering season. Based on these observations, Rich Inlet appears to have some of the highest observations of piping plovers in North Carolina south of Cape Lookout National Seashore (particularly during spring and fall migration).

According to the Audubon North Carolina data, since 2006, 43 individual piping plovers from the Great Lakes population have been recorded at New Topsail Inlet, along with three banded individuals from the Northern Great Plains population and nine banded individuals from the Atlantic Coast breeding population. **Table 5-11** lists the banded individuals that have been observed by year at New Topsail Inlet, along with whether the individual wintered at New Topsail Inlet or only used the area as a migration stopover. The number of individually banded

Great Lakes piping plovers has dropped from 14 or 15 in 2008-2010 to only one individual in 2015-2017. This individual ("-X,-L:-Of,GG") was the only documented wintering Great Lakes bird at New Topsail Inlet in the winters of 2014/2015, 2015/2016, and 2016/2017, and the only Great Lakes individual documented at any time of year in the latter two nonbreeding seasons. The individual "-X,-L:-Of,GG" hatched in 2011 in Vermillion, Michigan, so as of 2018, it is seven years old. It may have utilized New Topsail Inlet in the years before 2014; however, the unique bands that identify it were not placed on it until 2014.

Six of the 43 banded individuals from the Great Lakes population seen at New Topsail Inlet have also been recorded as wintering or migrating through Rich Inlet, and six of the 43 Great Lakes banded individuals have also been documented on Core Banks, in Cape Lookout National Seashore. **Table 5-12** lists the banded individuals that have been observed by year at Rich Inlet. Of the six individuals recorded at Rich Inlet, three have also been documented at Mason Inlet to the south. One individual that wintered at New Topsail Inlet and Rich Inlet in 2009/2010 (-X,-G/O/G:-O,--) has been documented at Mason Inlet, Rich Inlet, New Topsail Inlet, and South Core Banks in various years, most recently at South Core Banks in 2015. Very few nonbreeding surveys have been conducted along the coastline between New Topsail Inlet and Shackleford Banks (the closest end of Cape Lookout National Seashore), so it is likely that individuals utilize other nearby inlets for migration or wintering, but are not documented at those locations.

In **Section 5.1.4**, demographic modeling of the non-breeding piping plovers in North Carolina and elsewhere is presented, along with true survival and site fidelity rates for New Topsail Inlet and other inlets along the east coast of the U.S. (**Table 5-5**). The true survival rate calculated by Gibson et al. (2018) for New Topsail Inlet piping plovers is approximately 66%. The site fidelity rate (the rate at which individual plovers return to the site year after year) is higher, at approximately 74%. At New Topsail Inlet, many of the 53 documented banded plovers returned for at least three years. One individual, "-Of,gY:-X,-b," wintered at New Topsail Inlet for seven consecutive nonbreeding seasons (2007/2008 to 2013/2014). This individual from the Great Lakes population hatched in 2005, and so spent at least seven of its nine years wintering at New Topsail Inlet.

5.2.2. Action Area Conservation Needs of and Threats to Piping Plover

The Action Area is developed, mainly with residences. Residential and commercial development began in the mid-1960's. Large portions of the Action Area are presently lined with structures. Recreational use in the Action Area is quite high from residents and tourists, including beach driving. A wide range of recent and on-going 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 3-3** lists the most recent projects, within the past 5 years.

<u>*Inlet dredging and sand mining*</u>: New Topsail Inlet has been dredged by the Corps typically two to three times a year, while the inlet crossings and connecting channels have been typically dredged every 1-2 years (NCDENR, 2015). The Town of Topsail Beach has received authorization to also conduct maintenance dredging of this inlet on the same general schedule, with beach disposal during the winter work window.

Nourishment activities widen beaches, change their sedimentology and stratigraphy, alter coastal processes and often plug dune gaps and remove overwash areas. According to the BA, Topsail Beach has been nourished three times in the past 8 years: in the winter of 2010/2011, winter/spring of 2012, and the winter of 2013/2014.

Beach scraping 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 become more frequent on North Carolina beaches in the past 20 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.

Beach raking and rock-picking: 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 may 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). The Town of North Topsail Beach conducted significant rock-picking activities during the 2015 beach nourishment project, due to large amounts of rock and gravel. Rock-picking activities have continued within the North Topsail Beach project area annually since 2015, in order to remove larger material that continues to wash onto the beach as the dune and/or berm erodes.

Pedestrian Use of the Beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from boats, beachfront, and nearby residences. Gibson et al. (2018) rated the project area as receiving moderate levels of recreational use from boaters and beachgoers, compared to other inlets in Georgia, South Carolina, and North Carolina used by overwintering and migrating piping plovers. Although the mean number of people observed per km of survey area was relatively low compared to other sites (below 4), the number of dogs observed per km surveyed was the highest of all of the sites at almost three dogs per km.

Beach Driving: Topsail Beach allows vehicles on the beach between October 1 and March 28. Beach driving permits are limited to the purposes of fishing. Aerial photography indicates that vehicles frequently access all sandy portions along the inlet shoulders in New Topsail Inlet, including the estuarine shoreline. Impacts to piping plovers and piping plover habitat are discussed at length in **Section 5.1.4.** By far, Topsail Beach had the highest number of vehicles observed per km of any other site in Gibson et al. (2018), with almost one vehicle every 2 km.

Shoreline stabilization: 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. Sand geotubes 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). A sandbag revetment at least 1,800 lf long (with a geotube in front of a portion) was constructed in 2015 at the north end of North Topsail Beach, and more sandbags were recently added to protect a parking lot north of the revetment. In 2000 and 2001, sandbag revetments were installed on the north end of Figure Eight Island along Surf Court, Inlet Hook Road, and Comber Road. There are over 30 homes on Topsail Beach with existing sandbag structures.

Sand fencing: There are a few stretches of sand fencing along the shoreline on Topsail Beach.

5.2.3. Tables for Environmental Baseline for Piping Plover

Table 5-8. Highest number of observed piping plovers on a single date between December 1 and January 31 at New Topsail and Rich Inlets, 2006-2016. Data from Audubon North Carolina (Addison pers. comm. 2016) and NCWRC.

Season/Year	Inlet	
	Topsail	**Rich**
2006/2007	NR	5
2007/2008	4	8
2008/2009	18	7
2009/2010	13	5
2010/2011	NR	1
2011/2012	1	NR
2012/2013	1	7
2013/2014	7	10
2014/2015	9	11
2015/2016	7	8

NR = not reported

Table 5-9. Number of Individually Banded Piping Plovers Observed at New Topsail Inlet Each Year, 2006/2007 to 2016/2017. Data from Audubon NC (Chapin pers. comm. 2018) and NCWRC.

Year	Great Lakes	NGP	Atlantic	Total
2006/2007	2			2
2007/2008	6 (4 wintering*)			6 (4 wintering)
2008/2009	14 (7 wintering)			14 (7 wintering)
2009/2010	15 (7 wintering)		1	16 (7 wintering)
2010/2011	4 (2 wintering)		1	5 (2 wintering)
2011/2012	9 (2 wintering)		2	11 (2 wintering)
2012/2013	8 (2 wintering)	2		10 (2 wintering)
2013/2014	5 (1 wintering)	1 (wintering)	2 (1 wintering)	8 (3 wintering)
2014/2015	3 (1 wintering)	1 (wintering)	3 (1 wintering)	7 (3 wintering)
2015/2016	1 (wintering)	1 (wintering)	5 (1 wintering)	7 (3 wintering)
2016/2017	1 (wintering)	1 (wintering)	2 (1 wintering)	4 (3 wintering)

*wintering = present in December or January

Table 5-10. Number of Individually Banded Piping Plovers Observed at Rich Inlet Each Year, 2005/06 to 2015/16. Data from Audubon NC (Chapin pers. comm. 2018), and NCWRC.

Year	Great Lakes	NGP	Atlantic	Total
2005/06	0	1	0	1
2006/07	2	1	0	3
2007/08	0	1	0	1
2008/09	0	1	0	1
2009/10	6	1	0	7
2010/11	3	0	2	5
2011/12	3	0	0	3
2012/13	5	0	0	5
2013/14	8	2	3	13
2014/15	12	2	7	21
2015/16	9	1	7	17

Table 5-11. Banded piping plovers at New Topsail Inlet from 2006 to 2017. Data from Audubon NC (Chaplin pers. comm. 2018) and NCWRC (ncpaws.org, accessed 08/20/2018).

Band Combination	Migrant/Winter	Breeding Population	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017
--,--:-g/O,-X	M	GL				X							
--,--:-X,-b	M	GL					X						
--,--:-X,-b/O	M	GL				X		X					
--,--:-X,-g/O	M	GL					X						
--,-O:-X,-Y/O	M	GL	X										
--,RX:-Of,LG	W	GL		X	X								
--,-X:-Of,LG	W	GL			X	X	X						
--,--:-O,-b/O	M	GL						X					
--,-O:-X,-b/O/b	M	GL						X					
--,-L:-Of,GG	M	GL									X		
-O,--:-X,-b	M	GL			X	X	X	X	X				
-O,--:-X,-g	W	GL			X	X		X	X				
-O,--:-X,-G	M	GL				X							
-O,--:-X,-g/O/g	W	GL			X								
-O,--:-X,-L(74)	M	GL								X			
-O,--:-X,-Y	M	GL							X				
-O,--:-X,-Y/O	M	GL							X	X			
-O,--:-X,-g(133)	M	GL						X					
-O,-g:-X,-g/O	M	GL								X			
-Of,BR:-X,-B	M	GL				X							
-Of,GL:-X,-g	M	GL			X								
-Of,gY:-X,-b	W	GL		X	X	X	X	X	X	X			

-Of,O L/O/L:-X,-g	M	GL	X	X									
-Of,Y B/O:-X,-g	M	GL		X									
-Of,YB:-X,-g	M	GL								X			
-Of,YG:-X,-O	M	GL									X		
-X,--:-O,-B	M	GL							X				
-X,--:-O,-B(42)	M	GL							X				
-X,--:-O,-B/O/B	M	GL						X					
-X,-B:-Of,BO	W	GL		X	X	X							
-X,-g:--,-O	M	GL							X				
-X,-g:--,OY	W	GL		X	X	X							
-X,-G:-Of,YG	M	GL			X	X							
-X,-G/O/G:-O,--	W	GL				X							
-X,-L:-O,--	M	GL			X	X							
-X,-L:-Of,bO	M	GL			X								
-X,-L:-Of,GG	W	GL									X	X	X
-X,-O:-Of,BG	M	GL			X								
-X,-O/G:-O,--	M	GL						X					
-X,-R:-O,--	M	GL			X	X							
-X,-R:-Of,Rg	M	GL				X							
-X,-b:-Yf,YO	M	NGP							X				
--,BW:Yf,YP	M	NGP							X				
-Yf(A48),LW:-X,LO	W	NGP								X	X	X	X
-X,-- :-P(94), --	M	ATL										X	
-X,--:-Lf(K1),--	M	ATL									X		
-R,--:-Y,--	M	ATL				X	X						
GR,--:AY,--	M	ATL										X	
-Gf(UN9),--:-B,--	M	ATL										X	
-Gf(CMP),--:-O,--	M	ATL										X	X

-Gf(72),--:-O,--	W	ATL								X	X	X	X
-Af(E9),--:-X,--	M	ATL						X		X	X		
-Lf,YB:--,-W	M	ATL						X					

Table 5-12. Banded piping plovers at Rich Inlet, from 2005/2006 to 2016/2017. Data for 2016/2017 is preliminary. Data from Audubon NC (Chaplin pers. comm. 2018) and NCWRC (ncpaws.org, accessed 08/20/2018).

Band Combination	Brood Marker ID	Unique Combo	Migrant or Winter	Breeding Population	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017
-,Af(EK),--:-X,--		Yes	M	ATL Canada										X		
-bf(09),--:-Y,--		Yes	M	NGP US										X		
-G,--:-Gf(0V3),--		Yes	M	ATL US											X	X
-Gf(09),--:-Y,--		Yes	M	ATL US									X	X		
-Gf(6XW),--:-B,--		Yes	M	ATL US											X	X
-Gf(CAK),--:-B,--		Yes	M	ATL US												X
-Gf(V64),--:-O,--		Yes	M	ATL US											X	X
-Gf,GB:--,YG		Yes	M	ATL US									X	X	X	
-Gf,YG:--,YB		Yes	M	ATL US									X	X	X	X
-Lf(KV),--:-X,--		Yes	M	ATL Canada											X	
-Lf,gY:-X,-G		Yes	W	NGP C	X	X	X	X	X							
-Lf,LO:--,-W		Yes	M	ATL US										X		
-Lf,YB:--,-W		Yes	M	ATL US						X						
-O,--:-X,-G(005)	G(005), red dot	Yes	M	GL US									X			

-O,-b(036):-X,-b/O	b(036), O yellow dot	Yes	W	GL US											X	
-O,-b:-X,-b/O	037	Yes	W	GL US									X			
-O,-G/O/G:-X,-G		No	M	GL US										X		
-O,-g:-X,-g/O		Yes	W	GL US									X	X		
-O,-G:-X,-G/O		Yes	W	GL US										X	X	
-O,-O/g:-X,--		No	M	GL US										X		
-O,-Y/O:-X,--	blue dot on Y/O	Yes	M	GL US							X					
-Of,B/O L:-X,-b		Yes	W	GL US												X
-Of,GG:-X,-R		Yes	W	GL US												X
-Of,gY:-X,-g		Yes	M	GL US					X							
-Of,Lb:-X,-b		Yes	M	GL US										X		
-Of,LB:-X,-L		Yes	M	GL US										X		
-Of,OL/O/L:-X,-g		Yes	M	GL US		X										
-Of,RB:-b,-Y		Yes	W	GL US					X	X						
-Of,YB:-X,-g		Yes	W	GL US					X	X	X	X	X	X	X	X
-Of,YG:-X,-O		Yes	M	GL US											X	
-X,--:-Lf(E0),--		Yes	M	ATL Canada											X	
-X,--:-Lf(KK),--		Yes	M	ATL Canada												X
-X,--:-O,-B/O/B		Yes	W	GL US								X	X	X	X	X
-X,--:-O,-G/O/G		Yes	M	GL US								X			X	

-X,--:-Pf(26),--		Yes	M	ATL US										X		
-X,--:-Pf(52),--		Yes	M	ATL US										X		
-X,-B(115):--,-O	B(115)	Yes	M	GL US												X
-X,-b:-O,--		No	M	GL US						X	X					
-X,-b:-O,-b		No	M	GL US		X										
-X,-b:-Of,BR		Yes	M	GL US					X							
-X,-G/O/G:-O,--		Yes	W	GL US					X							
-X,g:-O,-Y		No	M	GL US					X							
-X,-G:-Yf,PL		Yes	W	NGP US									X	X		
-X,-L:-Of,YL		Yes	W	GL US									X	X	X	
-X,-O/g:-O,--		No	M	GL US										X		
-X,-O/G:-O,--		Yes	W	GL US									X	X	X	
-X,-O/Y:-O,--		Yes	W	GL US								X				
-X,-R(100):--,-O	R(100), green dot	Yes	M	GL US											X	
-X,-Y/O/Y:-O,--		Yes	M	GL US								X	X			
-X,-Y:--,-O		No	M	GL C										X		
-X,YR:-Yf(0E5),LW		Yes	W	NGP US											X	X
-Yf(A48),LW:-X,LO		Yes	M	NGP US												X
-Yf(N36),--:-X,--		Yes	M	NGP US									X			
YG,--:RR,--		Yes	M	ATL US						X						

5.3. Effects of the Action on Piping Plover

This section analyzes the direct and indirect effects of the Action on the Piping Plover, which includes the direct and indirect effects of interrelated and interdependent actions. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur.

5.3.1. Effects of Dredging on Piping Plover

Applicable Science and Response Pathways

The Service expects the Action will result in direct and indirect, long-term effects to piping plovers.

Direct Effects:

Short-term and temporary impacts to piping plovers could result from project activities disturbing roosting plovers and degrading or removing currently occupied adjacent foraging areas.

The construction window will extend through the piping plover migration and winter season and into the nesting season. Since piping plovers can be present on these beaches year-round, construction is likely to occur while this species is utilizing these intertidal shoals, beaches and associated habitats. Dredges operating in the Action Area may adversely affect piping plovers 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.

Dredging of this channel appears to require the removal of emergent shoals that may have formed over time. In this case, the dredging activities will result in a complete take of that habitat, at least until the area recovers a similar amount of sand and the shoals reform. After each dredging event, the loss of optimal habitat in the intertidal shoals will not be recovered unless and until sand movement again creates shoals in the project area. The mean linear distance moved by wintering plovers from their core area is estimated to be approximately 2.1 mi (Drake et al. 2001), suggesting they could be negatively impacted by temporary disturbances anywhere in their core habitat area.

In the construction area where shoals above MLLW are dredged, there will be direct loss of piping plover critical habitat in Unit NC-11, and of foraging and roosting habitat. The Service expects there may be morphological changes to adjacent piping plover habitat, including roosting and foraging 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 piping plover.

The timing of project construction could directly and indirectly impact migrating and wintering piping plovers. Piping plovers may be present year-round in the Action Area; however, the timing of project activities will likely occur during the migration and wintering period.

Indirect Effects:

Long-term and permanent impacts could preclude the creation of new habitat and increase recreational disturbance. The effects of the project construction include a long-term reduction in foraging habitat and a long-term decreased rate of change in coastal dynamics (e.g. sand movement to form shoals and other intertidal habitats) that may preclude habitat creation.

Indirect effects include reducing the potential for the formation of optimal habitats. 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. Recreational activities that potentially adversely affect plovers on the inlet shoals include disturbance by boats, unleashed pets and pedestrians.

Responses and Interpretation of Effects

The Service anticipates potential adverse effects throughout the Action Area by limiting proximity to roosting, foraging, and nesting habitat and by removing or degrading occupied foraging habitat.

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). 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. 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. Even small declines in adult and juvenile survival rates will cause increases in extinction risk (Ryan et al. 1993; Melvin and Gibbs 1996; Plissner and Haig 2000; Amirault et al. 2005; Calvert et al. 2006; Brault 2007; Gibson et al. 2018).

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.

The dredging of intertidal shoals in New Topsail Inlet will immediately destroy an unknown amount of piping plover critical habitat, directly in the path of the dredge. The dredging will also cause a long-term reduction in foraging and roosting habitat, and long-term decreased rate of change in coastal dynamics that may preclude creation of new optimal habitat. The Service estimates that the total amount of critical habitat removed or otherwise adversely affected is up to 200 acres, and the actual amount will be based on the amount of intertidal shoals dredged. However, the rest of the critical habitat unit and other critical habitat units should remain functional to serve the intended conservation role for the piping plover.

5.3.2. Effects of Sand Placement on Piping Plover

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 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 all shorebirds, including the piping plover.

<u>Applicable Science and Response Pathways</u>

Direct effects:

Heavy machinery and equipment (e.g., dredges, trucks and bulldozers operating in Action Area) 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. In addition, piping plovers may face increased predation from avian and mammalian predators attracted to the Action Area by food waste from the construction crew.

Indirect effects:

The Service expects there may be morphological changes to adjacent piping plover habitat, including roosting and foraging 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 piping plover.

Indirect effects include reducing the potential for the formation of optimal habitats. Overwash is an essential process, necessary to maintain the integrity of many barrier islands and to create new habitat (Donnelly et al. 2006). In a study on the Outer Banks of North Carolina, Smith et al. (2008) found that human "modifications to the barrier island, such as construction of barrier dune ridges, planting of stabilizing vegetation, and urban development, can curtail or even eliminate the natural, self-sustaining processes of overwash and inlet dynamics." The proposed project may limit overwash and 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. Recreational activities that potentially adversely affect plovers include disturbance by unleashed pets and increased use by beach drivers and pedestrians.

The Service anticipates potential adverse effects throughout the Action Area by limiting proximity to roosting, foraging, and nesting habitat and degrading occupied foraging habitat. Elliott and Teas (1996) found a significant difference in actions between piping plovers encountering pedestrians and those not encountering pedestrians. Piping plovers 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.

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 adjacent foraging areas. The effects of the project construction include a long-term reduction in foraging habitat and a long-term decreased rate of change in coastal dynamics (e.g. sand movement that forms shoals and other intertidal habitats) that may preclude habitat creation. 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.

The addition of dredged sediment can temporarily affect the benthic fauna of intertidal systems. Burial, crushing, and suffocation of invertebrate species will occur during the sand placement, and will affect up to 24,000 lf of shoreline. Although some benthic species can burrow through a thin layer of additional sediment (38-89 cm for different species), thicker layers (i.e., >1 meter) are likely to smother these sensitive benthic organisms (Greene 2002). Numerous studies of such effects indicate that the recovery of benthic fauna after beach nourishment or sediment placement projects can take anywhere from six months to two years, and possibly longer in extreme cases (Thrush et al. 1996; Peterson et al. 2000; Zajac and Whitlatch 2003; Bishop et al. 2006; Peterson et al. 2006). Sand placement projects bury the natural beach with up to millions of cubic yards of new sediment, and grade the new beach and intertidal zone with heavy equipment to conform to a predetermined topographic profile. If the material used in a sand placement project does not closely match the native material on the beach, the sediment incompatibility may result in modifications to the macroinvertebrate community structure, because several species are sensitive to grain size and composition (Rakocinski et al. 1996; Peterson et al. 2000; 2006; Peterson and Bishop 2005; Colosio et al. 2007; Defeo et al. 2009).

Delayed recovery of the benthic prey base or changes in their communities due to physical habitat changes may affect the quality of piping plover foraging habitat. The duration of the impact can adversely affect piping plovers because of their high site fidelity. Although recovery of invertebrate communities has been documented in many studies, sampling designs have typically been inadequate and have only been able to detect large-magnitude changes (Schoeman et al. 2000; Peterson and Bishop 2005). Therefore, uncertainty persists about the impacts of various projects to invertebrate communities and how these impacts affect shorebirds, particularly the piping plover.

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.

Responses and Interpretation of Effects

Sand placement activities widen beaches, change their sedimentology and stratigraphy, alter coastal processes and often plug dune gaps and remove overwash areas.

The proposed placement of sand on 24,000 lf of beach will occur within habitat for migrating and wintering piping plovers and construction will occur during a portion of the nesting, migration, and winter seasons. Piping plovers may be present year-round in the Action Area; however, the location of project activities will likely occur in areas used by migrating and wintering plovers. Sand nourishment under this authorization is expected to be a one-time event, taking up to four and a half months to complete. The Service expects the Action will result in direct and indirect, long-term effects to piping plovers. However, the Action Area has been developed for decades, with regular nourishment activities and a high level of recreational activity for over 10 years.

For this and other sand placement BOs, the Service typically uses a surrogate to estimate the extent of take. The amount of take is directly proportional to the spatial/temporal extent of occupied habitat that the Action affects, and exceeding this extent would represent a taking that is not anticipated in this BO. It is difficult for the Service to estimate the exact number of piping plovers that could be migrating through or wintering within the Action Area at any point in time and place during and after project construction and maintenance events. Disturbance to suitable habitat resulting from placement of sand would affect the ability of an undetermined number of piping plovers to find suitable foraging and roosting habitat during construction and maintenance for an unknown length of time after construction. Incidental take of piping plovers 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 may be carried away by waves or predators.

However, the level of take of this species can be anticipated by the proposed activities because:

(1) piping plovers breed, 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 and vehicular disturbance may be expected; and
(4) a temporary reduction of food base will occur.

5.4. Cumulative Effects on Piping Plover

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. 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. Potential cumulative effects are unknown at this time. Therefore, cumulative effects are not relevant to formulating our opinion for the Action.

5.5. Conclusion for Piping Plover

In this section, we summarize and interpret the findings of the previous sections for the piping plover (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"Jeopardize the continued existence" 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 (50 CFR §402.02).

Status

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 in the Action Area may include individuals from all three breeding populations. 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.

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.

Overall, it appears that the Northern Great Plains breeding population (including Canada) declined from 1991 through 2001, increased dramatically in 2006, and then declined again in 2011. The 2011 breeding census count was substantially lower than the count in 2006 (over 4,500 birds in 2006 and 2,249 in 2011) (Elliott-Smith et al. 2015).

The Great Lakes population has shown significant growth, from approximately 17 pairs at the time of listing in 1986, to 75 pairs in 2016 (Cavalieri pers. comm. 2016a). The total of 75

breeding pairs represents 50% of the current recovery goal of 150 breeding pairs for the Great Lakes population.

Baseline

Within the Action Area, wintering, migrating, and breeding piping plovers are documented every year. There have been as many as 15 documented piping plovers on one day during the winter and migration seasons, and typically one breeding pair during the breeding season. Overwintering and migrating piping plover individuals are most likely to be found in the estuary or far-field flood shoals of New Topsail Inlet, while breeding individuals and nests are typically found on the south end of Topsail Island. As many as 15 individually banded piping plovers utilized the inlet area annually between 2008 and 2010. This number dropped to five in 2010/2011 (the same year as the first of the most recent dredging projects), but increased to between seven and ten individuals from 2011/2012 to 2015/2016. In the winter of 2016/2017, only four individuals were recorded during the migration and wintering season (three of those during the winter months of December and January) (Chaplin pers. comm. 2018).

According to the Audubon North Carolina data, since 2006, 43 individual piping plovers from the Great Lakes population have been recorded at New Topsail Inlet, along with three banded individuals from the Northern Great Plains population and nine banded individuals from the Atlantic Coast breeding population (Chaplin pers. comm. 2018).

Effects

The Service anticipates potential adverse effects throughout the Action Area by limiting proximity to roosting, foraging, and nesting habitat and by removing or degrading occupied foraging habitat.

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). 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. 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. Even small declines in adult and juvenile survival rates will cause increases in extinction risk (Ryan et al. 1993; Melvin and Gibbs 1996; Plissner and Haig 2000; Amirault et al. 2005; Calvert et al. 2006; Brault 2007; Gibson et al. 2018).

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.

The dredging of intertidal shoals in New Topsail Inlet will immediately destroy an unknown amount of piping plover critical habitat, up to 200 acres, directly in the path of the dredge. The dredging will also cause a long-term reduction in foraging and roosting habitat, and long-term decreased rate of change in coastal dynamics that may preclude creation of new optimal habitat. However, the rest of the critical habitat unit and other critical habitat units should remain functional to serve the intended conservation role for the piping plover.

Sand placement activities widen beaches, change their sedimentology and stratigraphy, alter coastal processes and often plug dune gaps and remove overwash areas. The proposed placement of sand on 24,000 lf of beach will occur within habitat for piping plovers. Piping plovers may be present year-round in the Action Area; however, the location of project activities will likely occur in areas used by migrating and wintering plovers. Sand nourishment under this authorization is expected to be a one-time event, taking up to four and a half months to complete. The Service expects the Action will result in direct and indirect, long-term effects to piping plovers. Although the area of sand placement developed for decades, with regular nourishment activities and a high level of recreational activity, the area to be dredged provides optimal habitat for wintering and migrating piping plovers. Therefore, piping plover presence in the Action Area is often quite high.

It is reasonable to expect continued dredging, 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. These future projects are likely to require federal permits and therefore, are not considered to be cumulative effects.

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the piping plover.

6. CRITICAL HABITAT FOR PIPING PLOVER

6.1. Status of Piping Plover Critical Habitat

This section summarizes best available data about the current condition of all designated units of critical habitat for piping plover (*Charadrius melodus*) that are relevant to formulating an opinion about the Action. In 2001, critical habitat was designated for the breeding population in the Great Lakes region (USFWS 2001a), while a separate rule determined critical habitat for the U.S. portion of the Northern Great Plains breeding population in 2002 (USFWS 2002). No critical habitat has been proposed or designated for the Atlantic Coast breeding population, but the needs of all three breeding populations were considered in the 2001 critical habitat designation for wintering piping plovers (USFWS 2001b) and in subsequent re-designations (USFWS 2008b; 2009c).

As discussed in **Section 5.1** multiple recovery plans have been developed for the three piping plover populations and their migration/wintering habitat, along with a document outlining the

CCS for the piping plover in its coastal migration and wintering range (USFWS 2012; 2015).

6.1.1. Description of Piping Plover Wintering Critical Habitat

Critical habitat for wintering piping plovers currently comprises 141 units totaling 256,513 acres along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. The original designation included 142 units (the rule erroneously states 137 units) encompassing approximately 1,798 mi of mapped shoreline and 165,211 acres of mapped areas (USFWS 2001b). A revised designation for four North Carolina units was published in 2008 (USFWS 2008b). Eighteen revised Texas critical habitat units were designated in 2009, replacing 19 units that were vacated and remanded by a 2006 court order (USFWS 2009b). Designated areas include habitats that support roosting, foraging, and sheltering activities of piping plovers.

Critical habitat designation for the piping plover used the term PCEs to identify the key components of critical habitat that are essential to its conservation and may require special management considerations or protection. Revisions to the critical habitat regulations in 2016 (81 FR 7214, 50 CFR §4.24) discontinue use of the term PCEs, and rely exclusively on the term PBFs to refer to these key components, because the latter term is the one used in the statute. This shift in terminology does not change how the Service conducts a "destruction or adverse modification" analysis. In this BO, we use the term PBFs to label the key components of critical habitat that provide for the conservation of the piping plover that were identified in its critical habitat designation rule as PCEs.

The PBFs of piping plover critical habitat are (73 FR 62816-62841):

1. Intertidal sand beaches (including sand flats) or mud flats (between annual low tide and annual high tide) with no or very sparse emergent vegetation for feeding. In some cases, these flats may be covered or partially covered by a mat of blue-green algae.
2. Unvegetated or sparsely vegetated sand, mud, or algal flats above annual high tide for roosting. Such sites may have debris or detritus and may have micro-topographic relief (less than 20 in (50 cm) above substrate surface) offering refuge from high winds and cold weather.
3. Surf-cast algae for feeding.
4. Sparsely vegetated backbeach, which is the beach area above mean high tide seaward of the dune line, or in cases where no dunes exist, seaward of a delineating feature such as a vegetation line, structure, or road. Backbeach is used by plovers for roosting and refuge during storms.
5. Spits, especially sand, running into water for foraging and roosting.
6. Salterns, or bare sand flats in the center of mangrove ecosystems that are found above mean high water and are only irregularly flushed with sea water.
7. Unvegetated washover areas with little or no topographic relief for feeding and roosting. Washover areas are formed and maintained by the action of hurricanes, storm surges, or other extreme wave actions.

8. Natural conditions of sparse vegetation and little or no topographic relief mimicked in artificial habitat types (e.g., dredge spoil sites).

A designated unit contains one or more of these PBFs. The seaward edge of each unit is the contour of the mean lower low water (MLLW) elevation of each tidal day, as observed over the National Tidal Datum Epoch. The breadth of each unit extends landward from the seaward edge to where PBFs no longer occur, generally to the toe of stable, densely-vegetated dunes. The seaward and landward edges may shift over time with the movement of coastal landforms. Unit boundaries generally exclude developed areas, because these areas do not contain the PBFs. Buildings, marinas, paved areas, boat ramps, exposed oil and gas pipelines, and similar structures that may occur within unit boundaries do not contain the PBFs and are not considered critical habitat.

6.1.2. Conservation Value of Piping Plover Wintering Critical Habitat

The most recent comprehensive reviews of plover winter habitat conditions are the 2009 5-year status review (USFWS 2009a) and the 2015 winter/migration CCS (USFWS 2015). We summarize in this section key points from these documents that are relevant to this BO. Please refer to these documents for further details.

Characterizing the current conservation value of piping plover critical habitat is difficult, due to the multi-state scale of the designation and to the dynamic or ephemeral nature of its PBFs. Waves, tides, currents, storms, terrestrial runoff, and biological communities interacting with sediments at the land/sea interface form and maintain piping plover winter habitats. Various human activities at the land/sea interface (construction, dredging, sand mining, sand placement, inlet stabilization/relocation/closure, seawalls, revetments, beach cleaning) disrupt these processes and reduce or degrade the PBFs. Therefore, a common and practical approach to describing the status of plover critical habitat is to quantify the extent of human alteration of features or PBF surrogates that are easily measured at large scales. Beaches and inlets encompass multiple PBFs.

Not all units are equally important depending on the presence, juxtaposition, and acreage of components contributing to the PBFs, and not all units are equally important to the three breeding populations. Piping plovers from the three breeding populations are not evenly distributed throughout their nonbreeding range (Gratto-Trevor et al. 2012). The 141 critical habitat units vary from units which provide all of the PBFs, including a few that have very little human presence or disturbance, to very disturbed units where very few of the PBFs remain and piping plovers are rarely seen. There are many threats that degrade or remove PBFs of piping plover wintering critical habitat, including but not limited to those below. **Section 5.1.4** discusses many of these threats in more detail. The 2015 CCS includes a table to help the reader determine the relative importance of each threat, ranked as low, medium, or high based on how much of a threat they are to the wintering population (**Table 5-4).**

There are many man-made activities that threaten the PBFs. The wide, flat, sparsely vegetated barrier beaches, spits, sandbars, and bayside flats preferred by piping plovers in the U.S. are formed and maintained by natural forces and are thus susceptible to degradation caused by

development and shoreline stabilization efforts. As described below and in **Section 5.1.4**, barrier island and beachfront development, inlet and shoreline stabilization, inlet dredging, beach maintenance and nourishment activities, seawall installations, and mechanical beach grooming continue to alter natural coastal processes throughout the range of migrating and wintering piping plovers.

Using information provided on inlets in Rice (2012a), the Service determined that there are 151 inlets in the non-breeding range of the Great Lakes piping plover population (including inlets from North Carolina to the Florida Gulf of Mexico shoreline). Based on Rice (2012a), 19% of the inlets in piping plover critical habitat in this region have been modified by dredging/mining, shoreline hardening, or relocation. Of these modified inlets, approximately 34% are within piping plover critical habitat. In North Carolina, 16 of the 20 (75%) existing inlets are modified in some manner, most often by dredging (**Table 5-6**) (Rice 2016). This is higher than any other state in the non-breeding range of the Great Lakes piping plover population (Rice 2012a).

Development and Construction

Development and associated construction threaten the piping plover in its migration and wintering range by degrading, fragmenting, and eliminating habitat. Constructing buildings and infrastructure adjacent to the beach can eliminate roosting and loafing habitat (PBFs 2, 4, and 7 - see list in **Section 6.1.1**) within the development's footprint and degrade adjacent habitat by replacing sparsely vegetated dunes or back-barrier beach areas with landscaping, pools, fences, etc. In addition, bayside development can replace foraging habitat with finger canals, bulkheads, docks and lawns (PBFs 1, 2, 3, 5, 6, 7, and 8). High-value plover habitat becomes fragmented as lots are developed or coastal roads are built between oceanside and bayside habitats.

At present, there are approximately 2,119 mi of sandy beaches within the U.S. continental wintering range of the piping plover (Rice 2012b). Approximately 40% (856 mi) of these sandy beaches are developed, with mainland Mississippi (80%), Florida (57%), Alabama (55%), South Carolina (51%), and North Carolina (49%) comprising the most developed coasts (Rice 2012b). Developed beaches are highly vulnerable to further habitat loss because they cannot migrate in response to sea level rise.

Sand Placement

Sand placement projects threaten migration and wintering habitat of the piping plover in every state throughout the range (Rice 2012b). At least 684.8 mi (32%) of sandy beach habitat in the continental wintering range of the piping plover have received artificial sand placement via dredge disposal activities, beach nourishment or restoration, dune restoration, emergency berms, inlet bypassing, inlet closure and relocation, and road reconstruction projects, including over 91 mi in North Carolina. In most areas, sand placement projects are in developed areas or adjacent to shoreline or inlet hard stabilization structures in order to address erosion, reduce storm damages, or ameliorate sediment deficits caused by inlet dredging and stabilization activities. **See Section 5.1.4** for information on impacts to wintering habitat. These impacts threaten PBFs 1, 2, 3, 7, and potentially others, due to an increase in elevation of flats, removal of microtopography, and burial of surf-cast algae and wrack.

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 (PBFs 1, 2, 3, and also 5, when a sand spit is mined). 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. Most jettied inlets need maintenance dredging, but non-hardened inlets are often dredged as well. According to Rice (2012; 2016), approximately 44% of the inlets in the non-breeding range have been dredged or mined.

Shoreline Stabilization

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. This includes seawalls or adjacent development, which lock the inlets in place and affect the formation of shoals within the inlet. Rice (2012a) created database of the inlets within the migration and wintering range of the piping plover, including identification of existing hard structures or other habitat modifications. Several studies highlight concerns about adverse effects of development and coastline stabilization on the quantity and quality of habitat for migrating and wintering piping plovers and other shorebirds. Shoreline stabilization activities may affect PBFs 1, 2, 3, 4, 5, 6, and 7.

Groins (structures 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), resulting in the loss of habitat and preventing future piping plover habitat creation by limiting sediment deposition and accretion. 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 loss of sand from the inlet system can be exacerbated by inlet dredging and disposal outside of the inlet. Groins deflect longshore currents offshore. This aggravates downdrift erosion and erosion escarpments are common on the downdrift side of groins (Humiston and Moore 2001). Rice (2016) found that several inlets along the Atlantic Coast have hard stabilization structures such as jetties or groins along the entire inlet shoreline that have eliminated all sandy beach habitat from the inlet shoulders. Terminal groins along adjacent developed areas can alter erosion and accretion patterns and diminish the magnitude of the inlet cycle. As an example, the stabilization and dredging of Shinnecock Inlet on Long Island's South Shore in New York has directly negatively affected the inlet's ebb shoal equilibrium since construction in 1940. Buonaiuto et al. (2008) found that these impacts will persist for nearly 150 years and possibly longer. As of 2008, the ebb shoal had only reached approximately 60% of its

estimated equilibrium volume and it is expected to take another 75 years to reach full equilibrium. If the ebb shoal is mined or dredged, the time for recovery will increase.

These structures are found throughout the southeastern Atlantic Coast, and installation of new groins continues to occur. In North Carolina, there are three currently existing terminal groins, along Oregon Inlet, at Fort Macon along Beaufort Inlet in Carteret County, and on Bald Head Island in New Hanover County. The terminal groin on Bald Head Island was installed in 2014, but the other two (Oregon Inlet and Fort Macon) were installed decades ago, and downdrift erosion has been severe at both, requiring frequent nourishment (Pietrafesa 2012; Riggs et al 2009). The Oregon Inlet and Fort Macon Groins are located on the updrift side of the island, but accretion in these areas is not significant due to scour. At Oregon Inlet, there is no sandy habitat on the inlet shoulder updrift of the groin and revetment, and there has not been for decades. There are two degraded groin/jetty structures in Dare County, adjacent to the old location of the Cape Hatteras lighthouse. The Service has issued BOs for the authorization of two other terminal groins (Towns of Ocean Isle Beach and Holden Beach), and these projects are considered in the environmental baseline for the proposed project. The Figure Eight Homeowners Association has recently sought authorization to place a terminal groin on the north end of Figure Eight Island, on Rich Inlet. Also, in 2015, the North Carolina legislature revised state regulations to allow additional terminal groins to be constructed at New River Inlet and Bogue Inlet. However, it is unclear whether the local governments in the vicinity of these two inlets will propose the construction of a terminal groin.

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 (PBFs 1, 2, 3, 4, 5, 6, and 7). Seawalls confine the wave energy and intensify the erosion by concentrating the sediment transport processes in an increasingly narrow zone. Eventually, the beach disappears, leaving the seawall directly exposed to the full force of the waves (Williams et al 1995). 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. Sand geotubes 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). In 2014/2015, a sandbag revetment was constructed on over 1,800 lf of shoreline at the north end of Topsail Island, including portions along the New River Inlet shoreline. The intertidal areas and sand flats along the inlet were used as a sand source. The inlet shoreline north of the sandbag revetment has eroded significantly since installation. In 2016, the Town of North Topsail also placed a sandbag revetment above the MHWL along inlet shoulders of New River Inlet.

Inlet Relocation

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. This activity may affect PBFs 1, 2, 3, 4, and 5, by direct and indirect loss of intertidal shoal and adjacent shoreline habitat within the unit.

Exotic/invasive vegetation

The spread of coastal invasive plants is a threat to 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. The loss or degradation of this habitat may affect PBFs 1, 2, 3, 4, 5, 6, and 7.

Wrack removal and beach cleaning or rock-picking

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. 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 accumulated wrack, topographic depressions, and sparse vegetation nodes used by roosting and foraging piping plovers (PBFs 1, 2, 3, and 4). 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). The Town of Carolina Beach rakes the beach front in Freeman Park at least twice per year, including areas in piping plover critical habitat unit NC-14. The Town of North Topsail Beach utilizes a rock-picker as needed, typically annually, to remove rocky material from the beach berm along portions of its shoreline.

6.1.3. Conservation Needs for Piping Plover Wintering Critical Habitat

The 2012 CCS (USFWS 2012) synthesizes conservation needs across the shared coastal migration and wintering ranges of the three piping plover populations. Implementation of actions described in the CCS will support attainment of relevant reclassification and delisting criteria contained in the approved USFWS piping plover recovery plans for the Great Lakes and Atlantic Coast populations (USFWS 1996; 2003). Conservation efforts on behalf of piping plovers in their non-breeding range have increased since the species listing and further accelerated since the early 2000s. Diverse conservation tools are selectively used to address protection needs across

federal, state, municipal, and private land ownership. Current efforts toward conservation and recovery of piping plovers are discussed in **Section 5.1.4**. Most of these efforts also support the needs for conservation of critical habitat, including international treaties, regulatory protections, federal lands, and non-regulatory actions. State parks, wildlife management areas, and other lands furnish important habitat and protection for migrating and wintering piping plovers, including 23 percent of the 2001 critical habitat designation for wintering piping plovers (USFWS 2001b). Management protecting piping plovers has been implemented at various state parks in the wintering range.

Further, many of the proposed conservation and recovery actions outlined in the 2012 CCS for piping plover also support the needs for conservation of critical habitat. Please see **Table 5-8** for a complete list of the recommended actions from the Conservation Action Outline.

6.2. Environmental Baseline for Piping Plover Wintering Critical Habitat

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of designated critical habitat for piping plover within the Action Area. The environmental baseline is a "snapshot" of the condition of the PBFs that are essential to the conservation of the species within designated critical habitat of the Action Area at the time of the consultation, and does not include the effects of the Action under review.

6.2.1. Action Area Conservation Value of Piping Plover Wintering Critical Habitat

In North Carolina, there are 18 designated critical habitat units for wintering piping plover, from Oregon Inlet to Mad Inlet. Piping plover critical habitat unit NC-11 (Topsail – Pender and New Hanover Counties) is located within the Action Area. Portions of this 451 hectare (ha) (1,114 ac) unit are privately owned, while other portions are state-owned. This unit extends southwest from 1.0 km (0.65 mi) northeast of MLLW of New Topsail Inlet on Topsail Island to 0.53 km (0.33 mi) southwest of MLLW of Rich Inlet on Figure Eight Island. It includes both Rich Inlet and New Topsail Inlet and the former Old Topsail Inlet. This unit includes all land, including emergent sandbars, from MLLW on the Atlantic Ocean and sound side to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur (**Figure 6-1)**. In Topsail Sound, the unit stops as the entrance to tidal creeks becomes narrow and channelized. Critical habitat unit NC-11 includes two inlets, New Topsail Inlet and Rich Inlet, the inlet shoulders on both sides of the inlets, and all of Lea-Hutaff Island (**Figure 6-1**). The unit supports all of the PBFs listed in **Section 6.1.1** with the exception of PBFs 6 and 8. Salterns are not common in North Carolina, and there are no dredge spoil islands or other artificial habitats in the unit.

As of 2016 Unit NC-11 is providing wintering/migrating habitat for 10 plovers from the endangered Great Lakes breeding population, when individuals from Rich Inlet and Lea-Hutaff Island are included with those documented at New Topsail Inlet (**Tables 5-12 and 5-13**). The inlet shoulders also typically provide nesting habitat in most years for at least one breeding pair from the Atlantic Coast breeding population. The better the habitat quality, which is correlated with the amount of acres and juxtaposition of the PBFs, the more valuable the unit is. Higher quality units can attract higher numbers of piping plovers, particularly hatch-year birds, to

stopover or spend the winter. The project may have a larger impact on the local winter population, particularly plovers from the Great Lakes breeding population due to the high site fidelity of adult birds.

The majority of critical habitat unit NC-11 supports the PBFs for the piping plover, and the unit is of very high quality due to the relatively low level of human disturbance within much of the area – specifically along Lea-Hutaff Island and at Rich Inlet. Within New Topsail Inlet, the estuarine shoreline and intertidal shoals that are not attached to Topsail Island appear to support the PBFs more strongly than Topsail Island itself, likely due to threats that are discussed below.

In **Section 5.1.4** demographic modeling of the non-breeding piping plovers in North Carolina and elsewhere is presented, along with true survival and site fidelity rates for New Topsail Inlet, Rich Inlet, and other inlets along the east coast of the U.S. (**Table 5-5)**. The true survival rate calculated by Gibson et al. (2018) for New Topsail Inlet piping plovers is approximately 66% (not dissimilar to other disturbed inlet areas), while the true survival for Rich Inlet piping plovers is 92%, the highest by far of any inlet that was studied in Georgia, South Carolina, and North Carolina. The site fidelity rate (the rate at which individual plovers return to the site year after year) at New Topsail Inlet is higher than the survival rate, at approximately 74%. The site fidelity rate at Rich Inlet is 80%. The high survivorship of piping plovers using Unit NC-11, largely because of the high quality of the habitat within the entire unit and low disturbance along Rich Inlet and Lea-Hutaff Island, demonstrates the superior conservation potential and value of the critical habitat unit. It is possible that severe impacts to this wintering unit alone could cause a significant impact to the conservation and recovery of the Great Lakes piping plover population.

6.2.2. Action Area Conservation Needs for and Threats to Piping Plover Wintering Critical Habitat

Within critical habitat Unit NC-11, there are no specific management actions currently conducted to maintain the PBFs. The PBFs are typically maintained by natural coastal processes. Other than federal and state regulations, there are no additional protections of the PBFs in the unit. However, despite the lack of active management and protection, as stated above, the habitat within the majority of the unit is generally of high quality and subject to less overall disturbance than other units.

There are currently only a few regular threats to Unit NC-11, and most of them are associated with activities along New Topsail Inlet and the shoreline of Topsail Beach. **Table 3-3** lists the most recent projects within the past 5 years. **Table 5-6** lists impacts to inlets in North Carolina, including those in the Action Area. Impacts to the PBFs by these types of activities are discussed in **Section 6.1.2.**

<u>*Inlet dredging and sand mining*</u>: New Topsail Inlet has been dredged by the Corps typically two to three times a year, while the inlet crossings and connecting channels have been typically dredged every 1-2 years (NCDENR, 2015). The Town of Topsail Beach has received authorization to also conduct maintenance dredging of this inlet on the same general schedule,

with beach disposal during the winter work window. Rich Inlet and its associated channels have been dredged much less often; three times in the past 20 years.

Nourishment activities: According to the BA, Topsail Beach has been nourished three times in the past 8 years: in the winter of 2010/2011, winter/spring of 2012, and the winter of 2013/2014. The beaches of Figure Eight Island are regularly nourished with sand from Mason Inlet, and historically from Nixon Channel. Between 1993 and 2011, the northern end of Figure Eight Island was nourished with sand on six different occasions with sand from various sources, including Mason Inlet, Nixon Channel, Banks Channel, and Rich Inlet (CP&E of NC, Inc. 2016).

Beach scraping: Beach scraping or bulldozing has become more frequent on North Carolina beaches in the past 20 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. Beach scraping has been conducted 13 times on Figure Eight Island since 1977, including four times in the year 2000 alone (CP&E of NC, Inc. 2016). Data for beach scraping on Topsail Beach was not available.

Beach Driving: Topsail Beach allows vehicles on the beach between October 1 and March 28. Beach driving permits are limited to the purposes of fishing. Aerial photography indicates that vehicles frequently access all sandy portions along the inlet shoulders in New Topsail Inlet, including the estuarine shoreline. By far, Topsail Beach had the highest number of vehicles observed per km of any other site in Gibson et al. (2018), with almost one vehicle every 2 km. No beach driving is allowed on Rich Inlet, and Lea-Hutaff Island is not accessible to wheeled vehicles.

Shoreline stabilization: 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). A sandbag revetment at least 1,800 lf long (with a geotube in front of a portion) was constructed in 2015 at the north end of North Topsail Beach, and more sandbags were recently added to protect a parking lot north of the revetment. In 2000 and 2001, sandbag revetments were installed on the north end of Figure Eight Island along Surf Court, Inlet Hook Road, and Comber Road. There are over 30 homes on Topsail Beach with existing sandbag structures. Figure Eight Island Homeowners Association has sought authorization from the Corps for construction of a terminal groin on the north end of Figure Eight Island, but the project has not yet been authorized.

6.2.3. Figures for Action Area Conservation Needs for and Threats to Piping Plover Critical Habitat

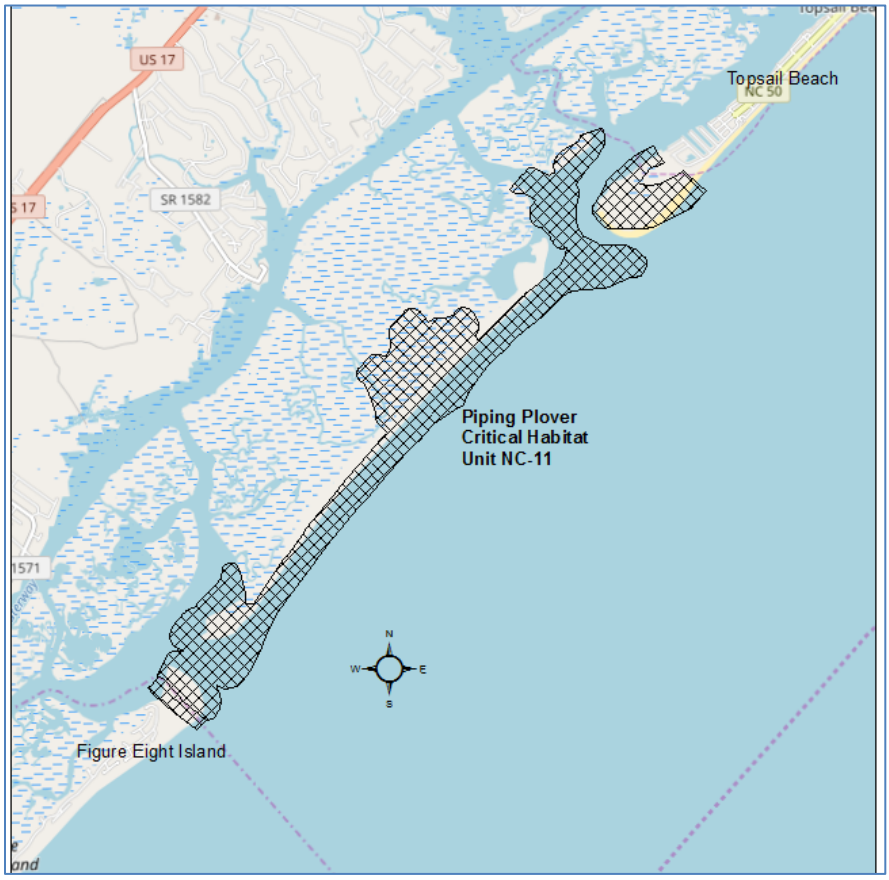


Figure 6-1. General location of piping plover critical habitat unit NC-11. Figure is not to scale.

6.3. Effects of the Action on Piping Plover Wintering Critical Habitat

This section analyzes the direct and indirect effects of the Action on critical habitat for piping plover, which includes the direct and indirect effects of interrelated and interdependent actions. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in **Section 2** of this BO.

6.3.1. Effects of Dredging on Piping Plover Wintering Critical Habitat

Applicable Science and Response Pathways

Direct Effects:

Dredging of this channel appears to require the removal of emergent shoals that may have formed over time. In this case, the dredging activities will result in an elimination of PBFs 1, 2, and 3 in those areas, at least until the area recovers a similar amount of sand and the shoals reform. After each dredging event, the loss of optimal habitat in the intertidal shoals will not be recovered unless and until sand movement again creates shoals in the project area. In the construction area where shoals above MLLW are dredged, there will be direct loss of piping plover critical habitat in Unit NC-11, and of foraging and roosting habitat. The Service expects there may be morphological changes to the PBFs in adjacent piping plover habitat in the Unit, including PBFs 1, 2, 3, 4, 5, and 7. 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 piping plover.

Indirect Effects:

Long-term and permanent impacts could preclude the creation of new habitat and increase recreational disturbance (though this type of disturbance is not relevant to the PBFs). The effects of the project construction include a long-term reduction in foraging habitat and a long-term decreased rate of change in coastal dynamics that may preclude the creation or restoration of optimal foraging and roosting habitat.

Responses and Interpretation of Effects

The Service anticipates potential adverse effects to six of the eight PBFs of piping plover wintering critical habitat throughout the Action Area, by removing or degrading occupied foraging and roosting habitat.

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. 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.

The dredging of intertidal shoals in New Topsail Inlet will immediately destroy an unknown amount of piping plover critical habitat and PBFs, directly in the path of the dredge. The Service has estimated that as much as 200 acres of critical habitat may be destroyed or adversely affected. The dredging will also cause a long-term reduction in foraging and roosting habitat, and long-term decreased rate of change in coastal dynamics that may preclude creation of new optimal habitat. However, the rest of the critical habitat unit and other critical habitat units should remain functional to serve the intended conservation role for the piping plover.

6.3.2. Effects of Sand Placement on Piping Plover Wintering Critical Habitat

The proposed action has the potential to adversely affect piping plover wintering critical habitat within a portion of the Action Area. Potential effects to six of the eight PBFs include direct loss of preferred foraging and roosting habitat in the Action Area and less suitable foraging and roosting habitat as a result of indirect, long-term impacts.

Applicable Science and Response Pathways

Direct effects:

The Action involves heavy machinery and equipment (e.g., dredges, trucks and bulldozers operating in Action Area) and placement of sand that may adversely affect PBFs 1, 2, 3, 4, 5, and 7 in a portion of the critical habitat unit. Crushing from equipment or burial by sand placement may degrade or modify by degrading or modifying the prey base in the intertidal zone. Sand placement will affect the presence of wrack, surf-cast algae, and micro-topographic features.

Indirect effects:

The Service anticipates potential adverse effects throughout the Action Area by limiting proximity to roosting and foraging habitat and degrading occupied habitat within the critical habitat unit (PBFs 1, 2, 3, 4, 5, and 7). Indirect effects include long-term degradation in PBFs and a reduction in the potential for the formation of PBFs.

Overwash is an essential process, necessary to maintain the integrity of many barrier islands and to create new habitat (Donnelly et al. 2006). The proposed project may limit overwash and the creation of optimal foraging and roosting habitat.

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 degrading currently occupied adjacent foraging and roosting areas. The effects of the project construction include a long-term reduction in foraging habitat, a long-term decreased rate of change in coastal dynamics that may preclude habitat creation.

The addition of dredged sediment can temporarily affect the benthic fauna of intertidal systems. Burial, crushing, and suffocation of invertebrate species will occur during the sand placement, and will affect up to 24,000 lf of shoreline. Sand placement projects bury the natural beach with up to millions of cubic yards of new sediment, and grade the new beach and intertidal zone with

heavy equipment to conform to a predetermined topographic profile. If the material used in a sand placement project does not closely match the native material on the beach, the sediment incompatibility may result in modifications to the macroinvertebrate community structure, because several species are sensitive to grain size and composition (Rakocinski et al. 1996; Peterson et al. 2000; 2006; Peterson and Bishop 2005; Colosio et al. 2007; Defeo et al. 2009).

Delayed recovery of the benthic prey base or changes in their communities due to physical habitat changes may affect the quality of piping plover foraging habitat (PBFs 1, 3, 5, 7). The duration of the impact can adversely affect piping plovers because of their high site fidelity. Although recovery of invertebrate communities has been documented in many studies, sampling designs have typically been inadequate and have only been able to detect large-magnitude changes (Schoeman et al. 2000; Peterson and Bishop 2005). Therefore, uncertainty persists about the impacts of various projects to invertebrate communities and how these impacts affect shorebirds, particularly the piping plover.

Responses and Interpretation of Effects

Sand placement activities bury food items, alter coastal processes, often plug dune gaps and remove overwash areas, and increase other forms of disturbance.

The proposed placement of sand on 24,000 lf of beach will occur within critical habitat for migrating and wintering piping plovers and construction will occur during a portion of the nesting, migration, and winter seasons. The Service expects the Action will result in direct and indirect, long-term effects to six of the eight PBFs, due to direct impacts from equipment on the beach, burial of prey items, and creating a long-term decreased rate of change in coastal dynamics that may degrade the PBFs or preclude PBF creation. However, the sand placement area is largely outside of the critical habitat unit.

6.4. Cumulative Effects on Piping Plover Wintering Critical Habitat

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. 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. Potential cumulative effects are unknown at this time. Therefore, cumulative effects are not relevant to formulating our opinion for the Action.

6.5. Conclusion for Piping Plover Wintering Critical Habitat

In this section, we summarize and interpret the findings of the previous sections for piping plover critical habitat (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"*Destruction or adverse modification*" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02).

Baseline

This critical habitat unit is one of 141designated critical habitat units for wintering piping plovers and one of 18 in North Carolina.

All designated critical habitat for wintering piping plovers in North Carolina is occupied, although some of the designated critical habitat units contain little to none of the components supporting the PBFs essential to the conservation of the species. There are many threats that degrade or remove PBFs of piping plover wintering critical habitat.

The 18 units in North Carolina vary in conservation value; though more than half support at least six of the PBFs (salterns are rare, as are dredge spoil sites with high usage by piping plover). The critical habitat unit in the Action Area provides very high quality wintering habitat for all three piping plover populations, and is of very high conservation value to the species, despite recreational pressures on the northern end of the unit. Many of the units in North Carolina have been affected historically or recently by activities such as dredging, inlet relocation, beach nourishment, and shoreline stabilization.

Effects

The Service anticipates potential adverse effects to six of the eight PBFs of piping plover wintering critical habitat throughout the Action Area, by removing or degrading occupied foraging and nesting habitat.

The dredging of intertidal shoals in New Topsail Inlet will immediately destroy as much as 200 acres of piping plover critical habitat directly in the path of the dredge, thereby affecting PBFs 1, 2, and 3 until shoals return. The dredging will also cause a long-term reduction in foraging and roosting habitat, and long-term decreased rate of change in coastal dynamics that may preclude creation of new optimal habitat (PBFs 1, 2, 3, 4, 5, and 7). However, the rest of the critical habitat unit and other critical habitat units should remain functional to serve the intended conservation role for the piping plover.

The proposed placement of sand on 24,000 lf of beach will occur within habitat for migrating and wintering piping plovers and construction will occur during a portion of the nesting, migration, and winter seasons. The Service expects the Action will result in direct and indirect, long-term effects to six of the eight PBFs, due to direct impacts from equipment on the beach, burial of prey items, immediate and long-term physical changes in habitat availability and quality, and creating a long-term decreased rate of change in coastal dynamics that may preclude habitat creation. However, the Action Area has been developed for decades, with regular

nourishment activities and a high level of recreational activity for over 10 years. The sand placement should affect a relatively small portion of the critical habitat unit. The rest of the critical habitat unit and other critical habitat units should remain functional to serve the intended conservation role for the piping plover.

After reviewing the current status of the critical habitat, the environmental baseline for the Action Area, the effects of the Action, and the cumulative effects, it is the Service's biological opinion that the Action is not likely to destroy or adversely modify designated critical habitat for wintering piping plovers.

7. RED KNOT

7.1. Status of Red Knot

This section summarizes best available data about the biology and current condition of red knot (*Calidris canutus rufa*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the rufa red knot as threatened on December 11, 2014 (79 FR 73706

7.1.1. Description of Red Knot

The red knot is a medium-sized shorebird about 9 to 11 in (23 to 28 cm) in length. The red knot migrates annually between its breeding grounds in the Canadian Arctic and several wintering regions, including the Southeast U.S. (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 seasons (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 U.S. 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 U.S. 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.

7.1.2. Life History of Red Knot

Each year red knots make one of the longest distance migrations known in the animal kingdom, traveling up to 19,000 mi (30,000 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 areas in Patagonia, Argentina; eastern Brazil; northern Brazil; the Virginia barrier islands (U.S.); and Delaware Bay (Delaware and New Jersey, U.S.) (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, U.S.; 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 U.S. 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 U.S. (i.e., greater than 25 mi 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 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 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; *Donax* and *Darina* clams; snails and other mollusks, with polychaete 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 also prey on horseshoe crab eggs when available in other states.

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.

7.1.3. Numbers, Reproduction, and Distribution of Red Knot

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 in the timing of the birds' annual migratory cycle relative to favorable food and weather conditions.

In the U.S., 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 remain 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) 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 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 7-1**). 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.

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 route prior to the survey window. Thus, greater numbers of red knots may utilize Southeastern stopovers than suggested by the data in **Table 7-1**. For example, a peak count of over 8,000 red knots was documented in South Carolina during spring 2012 (SCDNR

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.

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 U.S. 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, the mid-Atlantic, and the Northeast U.S. *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. 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 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).

7.1.4. Conservation Needs of and Threats to Red Knot

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.

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 (National Research Council (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 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 ft (0.18 to 0.59 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 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 7-2** 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.

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 (CCSP 2009; 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 2009; Frumhoff et al. 2007; Thieler and Hammar-Klose 2000; Thieler and Hammar-Klose 1999).

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 U.S. 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 2009). 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 2009; 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).

Climate change is also resulting in asynchronies during the annual cycle of the red knot. 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). Threats to the red knot from shoreline stabilization are similar to those for the wintering piping plover (**Section 5.1.4**). 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, 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 2009; 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). 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 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. 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 (Greene 2002).

The artificial beach created by nourishment may provide only suboptimal habitat for red knots. 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. 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).

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 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) 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 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 U.S. 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 U.S., 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 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. Subsistence shorebird hunting was 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.

Predation

In wintering and migration areas, the most common predators of red knots are peregrine falcons, harriers (*Circus spp*.), accipiters (Family Accipitridae), merlins, shorteared owls (*Asio flammeus*), and greater black-backed gulls (*Larus marinus*) (Niles et al. 2008). Other large predators 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 (*Larus argentatus*) and glaucous gulls (*Larus hyperboreus*), gyrfalcon (*F. 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 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.

Sand fencing

Sand fencing captures windblown sand, bolstering dunes and altering the beach profile (Rice 2017). When fences are installed seaward of houses, the sand fencing displaces the dune crest farther seaward than would naturally occur (Nordstrom and McCluskey 1985). The installation of sand fencing in overwash areas hastens the conversion of these flat, bare areas to elevated, vegetated dune habitat. Between 2012 and early 2016, 62.69 mi (19%) of sandy beach habitat in North Carolina was modified by sand fencing.

Table 5-5 lists biological opinions since 2014 within the Raleigh Field Office geographic area that have been issued for adverse impacts to piping plovers and red knots. The BOs include those for beach renourishment, sandbag revetments, and terminal groin construction, all of which are included in the Environmental Baseline for this BO. In each of these BOs, a surrogate (linear footage of shoreline) was used to express the amount or extent of anticipated incidental take.

7.1.5. Summary of Red Knot Status

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 in the timing of the birds' annual migratory cycle relative to favorable food and weather conditions. 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.

Long-distance migrant shorebirds such as the red knot 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).

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.

7.1.6. Tables for Status of Red Knot

Table 7-1. Red knot counts along the Atlantic coast of the U.S., May 20 to 24, 2006 to 2012 (A. Dey pers. comm. October 12, 2012; Dey et al. 2011).

State	2006	2007	2008	2009	2010	2011	2012
New Jersey	7,860	4,445	10,045	16,229	8,945	7,737	23,525
Delaware	820	2,950	5,350		5,530	5,067	3,433
Maryland			663	78	5	83	139
Virginia	5,783	5,939	7,802	3,261	8,214	6,236	8,482
North Carolina	235	304	1,137	1,466	1,113	1,868	2,832
South Carolina		125	180	10	1,220	315	542
Georgia	796	2,155	1,487		260	3,071	1,466
Florida			868	800	41		10
Total	15,494	15,918	27,532	21,844	25,328	24,377	40,429

Table 7-2. 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

7.2. Environmental Baseline for Red Knot

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the Red Knot, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

7.2.1. Action Area Numbers, Reproduction, and Distribution of Red Knot

Migrating and overwintering hatch-year and adult red knots utilize the Action Area. Red knots may be present any month of the year, although they are less likely to be present during the height of the breeding season (July). Spring migration peaks in North Carolina in May-June, while fall migration peaks between mid-August and early September, though many individuals stay until November, and small flocks may stay for the entire winter (nc.audubon.org).

There have been only a handful of surveys for red knots at New Topsail Inlet since 2010. Data from NCWRC (ncpaws.org, accessed August 20, 2018) indicate that 123 red knots were documented in the New Topsail Inlet area (on the south end of Topsail Beach, in New Topsail Inlet, or on the north end of Lea Island) on January 26, 2016, and 109 were documented on February 1, 2016. Other surveys in 2010 and 2011 document fewer individuals, as many as 18 on one day.

7.2.2. Action Area Conservation Needs of and Threats to Red Knot

The Action Area is developed, mainly with residences. Residential and commercial development began in the mid-1960's. Large portions of the Action Area are presently lined with structures. Recreational use in the Action Area is quite high from residents and tourists, including beach driving. In recent years, piping plover nests on the south end of Topsail Beach have been protected during the breeding season, using posts and rope. These roped off areas may also provide areas for red knots to be free from human disturbance for a small portion of the year.

A wide range 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 3-3** lists the most recent projects, within the past 5 years.

Nourishment activities: According to the BA, Topsail Beach has been nourished three times in the past 8 years: in the winter of 2010/2011, winter/spring of 2012, and the winter of 2013/2014.

Beach scraping: Beach scraping or bulldozing has become more frequent on North Carolina beaches in the past 20 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.

Beach raking: The Town of North Topsail Beach conducted significant rock-picking activities during the 2015 beach nourishment project, due to large amounts of rock and gravel. Rock-picking activities have continued within the North Topsail Beach project area annually since 2015, in order to remove larger material that continues to wash onto the beach as the dune and/or berm erodes.

Pedestrian use of the beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from boats, beachfront, and nearby residences. Gibson et al. (2018) rated the project area as receiving moderate levels of recreational use from boaters and beachgoers, compared to other inlets in Georgia, South Carolina, and North Carolina used by overwintering and migrating red knots. Although the mean number of people observed per km of survey area was relatively low compared to other sites (below 4), the number of dogs observed per km surveyed was the highest of all of the sites at almost three dogs per km.

Beach driving: Topsail Beach allows vehicles on the beach between October 1 and March 28. Beach driving permits are limited to the purposes of fishing. Aerial photography indicates that vehicles frequently access all sandy portions along the inlet shoulders in New Topsail Inlet, including the estuarine shoreline. Impacts to red knots are similar to those of piping plover, discussed at length in **Section 5.1.4.** By far, Topsail Beach had the highest number of vehicles observed per km of any other site in Gibson et al. (2018), with almost one vehicle every 2 km.

Shoreline stabilization: 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). A sandbag revetment at least 1,800 lf long (with a geotube in front of a portion) was constructed in 2015 at the north end of North Topsail Beach, and more sandbags were recently added to protect a parking lot north of the revetment. In 2000 and 2001, sandbag revetments were installed on the north end of Figure Eight Island along Surf Court, Inlet Hook Road, and Comber Road. There are over 30 homes on Topsail Beach with existing sandbag structures.

Sand fencing: There are a few stretches of sand fencing along the shoreline on Topsail Beach.

7.3. Effects of the Action on Red Knot

This section analyzes the direct and indirect effects of the Action on the red knot, which includes the direct and indirect effects of interrelated and interdependent actions. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in S**ection 2** of this BO.

7.3.1. Effects of Dredging on Red Knot

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 due to dredging of intertidal habitats and placement of sandy material.

Applicable Science and Response Pathways

The Service expects the Action will result in direct and indirect, long-term effects to red knots.

Direct Effects:

Short-term and temporary impacts to red knots could result from project activities disturbing roosting red knots and degrading or removing currently occupied adjacent foraging and roosting areas.

The construction window will extend through the red knot migration and winter season. Since red knots can be present on these beaches year-round, construction is likely to occur while this species is utilizing these intertidal shoals, beaches and associated habitats. Dredges operating in the Action Area may adversely affect red knots 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.

Dredging of this channel appears to require the removal of emergent shoals that may have formed over time. In this case, the dredging activities will result in a complete take of that habitat, at least until the area recovers a similar amount of sand and the shoals reform. After each dredging event, the loss of optimal habitat in the intertidal shoals will not be recovered unless and until sand movement again creates shoals in the project area. These areas are important during the migration and wintering season, as the inlet shoulder on Topsail Beach is typically subject to pedestrian and vehicular traffic, which may push red knots to utilize inlet shoals that are less disturbed by human presence.

In the construction area where shoals above MLLW are dredged, there will be direct loss of foraging and roosting habitat. The Service expects there may be morphological changes to adjacent red knot roosting and foraging 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 red knot.

The timing of project construction could directly and indirectly impact migrating and wintering red knot. Red knots may be present year-round in the Action Area, however, the timing of project activities will likely occur during the migration and wintering period.

Indirect Effects:

Long-term and permanent impacts could preclude the creation of new habitat and increase recreational disturbance. The effects of the project construction include a long-term reduction in foraging habitat and a long-term decreased rate of change in coastal dynamics that may preclude habitat creation.

Indirect effects include reducing the potential for the formation of optimal habitats. 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. Recreational activities that potentially adversely affect red knots on the inlet shoals include disturbance by boats, unleashed pets and pedestrians.

Responses and Interpretation of Effects

The Service anticipates potential adverse effects throughout the Action Area by limiting proximity to roosting and foraging and by removing or degrading occupied foraging habitat.

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 of the species. Threats on the wintering grounds may impact red knots' breeding success if they start migration or arrive at the breeding grounds with a poor body condition. 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. Information about the energetics of avian migration indicates that this might be a particularly critical time in the species' life cycle.

The dredging of intertidal shoals in New Topsail Inlet will immediately destroy as much as 200 acres of red knot foraging and roosting habitat, directly in the path of the dredge. The dredging will also cause a long-term reduction in foraging and roosting habitat, and long-term decreased rate of change in coastal dynamics that may preclude creation of new optimal habitat.

7.3.2. Effects of Sand Placement on Red Knot

The proposed action has the potential to adversely affect wintering and migrating red knots and their habitat. Potential effects to red knots include 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.

Applicable Science and Response Pathways

Placement of sand will occur within and adjacent to red knot roosting and foraging habitat along 24,000 lf of oceanfront shoreline. The timing of project construction could directly and indirectly impact migrating and wintering red knots. The effects of the project construction include a temporary reduction in foraging habitat, a long term decreased rate of change in coastal dynamics 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.

Dredging and beach nourishment will be a one-time activity, which will take up to four and a half months to complete. 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 from construction activities will be short

term, lasting up to two years. Recreational disturbance may increase after project completion and have long-term impacts.

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 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. 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.

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 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 placement activity. Impacts will affect up to 24,000 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 along up to 24,000 lf of shoreline. Indirect effects include reducing the potential for the formation of optimal roosting and foraging habitats (coastal marine and estuarine habitats with large areas of exposed intertidal sediments). The proposed project may also increase the attractiveness of these beaches for recreation increasing recreational pressures within the Action Area. Recreational activities that potentially adversely affect red knots include disturbance by unleashed pets and increased pedestrian or beach vehicle use.

Responses and Interpretation of Effects

The proposed placement of sand on 24,000 lf of beach 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. Sand nourishment under this authorization is expected to be a one-time event, taking up to four and a half months to complete. The Service expects the Action will result in direct and indirect, long-term effects to red knot. 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 sand. The area of sand placement has been developed for decades, with regular nourishment activities and a high level of recreational activity.

For this and other sand placement BOs, the Service typically uses a surrogate to estimate the extent of take. The amount of take is directly proportional to the spatial/temporal extent of occupied habitat that the Action affects, and exceeding this extent would represent a taking that is not anticipated in this BO. It is difficult for the Service to estimate the exact number of 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 red knots to find suitable foraging and roosting habitat during any given year.

The Service anticipates that directly and indirectly an unspecified amount of red knots along 24,000 lf of shoreline, all at some point, potentially usable by red knots, could be taken in the form of harm and harassment as a result of this proposed action. The amount of take is directly

proportional to the spatial/temporal extent of occupied habitat that the Action affects, and exceeding this extent would represent a taking that is not anticipated in this BO. Incidental take of 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 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) 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 or vehicular disturbance may be expected; and
(4) a temporary reduction of food base will occur.

7.4. Cumulative Effects on Red Knot

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. It is reasonable to expect continued dredging, 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.

7.5. Conclusion for Red Knot

In this section, we summarize and interpret the findings of the previous sections for the Red Knot (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"Jeopardize the continued existence" 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 (50 CFR §402.02).

Status

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 in the timing of the birds' annual migratory cycle relative to favorable food and weather conditions.

Baseline

Migrating and overwintering hatch-year and adult red knots utilize the Action Area. Red knots may be present any month of the year, although they are less likely to be present during the height of the breeding season (July). Data from NCWRC (ncpaws.org, accessed August 20, 2018) indicate that 123 red knots were documented in the New Topsail Inlet area (on the south end of Topsail Beach, in New Topsail Inlet, or on the north end of Lea Island) on January 26, 2016, and 109 were documented on February 1, 2016. Other surveys in 2010 and 2011 document fewer individuals, as many as 18 on one day.

Effects

The proposed placement of sand on 24,000 lf of beach 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. Sand nourishment under this authorization is expected to be a one-time event, taking up to four and a half months to complete. The Service expects the Action will result in direct and indirect, long-term effects to red knots. 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 sand. However, the Action Area has been developed for decades, with regular nourishment activities and a high level of recreational activity. There are no optimal habitats that will be affected. Therefore, the severity of these effects to the red knot population is expected to be slight.

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the red knot.

8. SEABEACH AMARANTH

8.1. Status of Seabeach Amaranth

This section summarizes best available data about the biology and current condition of seabeach amaranth (*Amaranthus pumilus*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the seabeach amaranth as threatened on April 7, 1993 (58 FR 18035).

8.1.1. Description of Seabeach Amaranth

Seabeach amaranth 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 ESA 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 in 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.

8.1.2. Life History of Seabeach Amaranth

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).

8.1.3. Numbers, Reproduction, and Distribution of Seabeach Amaranth

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).

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. In 2014, there was a slight increase in the number of plants to 2,829 (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 188 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 influence stochastic events have on long-term population trends of seabeach amaranth has not been assessed.

8.1.4. Conservation Needs of and Threats to Seabeach Amaranth

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 raking and scraping, 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

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.

8.2. Environmental Baseline for Seabeach Amaranth

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of seabeach amaranth, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

8.2.1. Action Area Numbers, Reproduction, and Distribution of Seabeach Amaranth

Since 1992, seabeach amaranth surveys have been conducted along much of the North Carolina shoreline. The numbers of seabeach amaranth vary widely from year to year. See **Table 8-1** for data from the Corps and the Service (unpublished). Seabeach amaranth numbers have been very high in the past on Topsail Island, numbering in the thousands of individuals in the 1990s and early 2000's. Over the past 10-20 years, the numbers of seabeach amaranth plants has plummeted, with only 10 plants reported in 2013 and 38 reported in 2014 along the entire island shoreline. According to the BA, the Applicant's consultant counted four plants within the project footprint in each year from 2014 to 2016 (Land Management Group 2018). Since 1992, the statewide total number of seabeach amaranth records has varied from as few as 105 plants in the year 2000 to 33,514 plants in 1995. Over the past 12 years, the numbers of seabeach amaranth have declined dramatically across the state. It is unclear what is causing the decline in numbers of plants.

8.2.2. Action Area Conservation Needs of and Threats to Seabeach Amaranth

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).

Table 8-2 lists biological opinions that have been issued for adverse impacts to seabeach amaranth since 2014, within the Raleigh Field Office geographic area. Activities addressed by the BOs include inlet dredging, sand placement, construction of sandbag revetments, and terminal groin construction.

The Action Area is developed, mainly with residences. Residential and commercial development began in the mid-1960's. Large portions of the Action Area are presently lined with structures. Recreational use in the Action Area is quite high from residents and tourists, including beach driving. A wide range 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 3-3** lists the most recent projects, within the past 5 years.

Nourishment activities: According to the BA, Topsail Beach has been nourished three times in the past 8 years: in the winter of 2010/2011, winter/spring of 2012, and the winter of 2013/2014.

Beach scraping: Beach scraping or bulldozing has become more frequent on North Carolina beaches in the past 20 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. Data concerning beach scraping is not available for Topsail Beach.

Beach raking: The Town of North Topsail Beach conducted significant rock-picking activities during the 2015 beach nourishment project, due to large amounts of rock and gravel. Rock-picking activities have continued within the North Topsail Beach project area annually since 2015, in order to remove larger material that continues to wash onto the beach as the dune and/or berm erodes.

Pedestrian Use of the Beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from beachfront and nearby residences.

Beach Driving: Topsail Beach allows vehicles on the beach between October 1 and March 28. Beach driving permits are limited to the purposes of fishing. Aerial photography indicates that vehicles frequently access all sandy portions along the inlet shoulders in New Topsail Inlet, including the estuarine shoreline. Impacts to seabeach amaranth are discussed in **Section 8.1.4.** By far, Topsail Beach had the highest number of vehicles observed per km of any other site in Gibson et al. (2018), with almost one vehicle every 2 km.

Shoreline stabilization: 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). A sandbag revetment at least 1,800 lf long (with a geotube in front of a portion) was constructed in 2015 at the north end of North Topsail Beach, and more sandbags were recently added to protect a parking lot north of the revetment. In 2000 and 2001, sandbag revetments were installed on the north end of Figure Eight Island along Surf Court, Inlet Hook Road, and Comber Road. There are over 30 homes on Topsail Beach with existing sandbag structures.

Sand fencing: There are a few stretches of sand fencing along Topsail Beach.

8.2.3. Tables for Environmental Baseline for Seabeach Amaranth

Table 8-1. Annual seabeach amaranth records in North Carolina, from 1987 to 2014. Data from various sources, collated by the Service.

Year	Dare Co.	Pea I. NWR	Cape Hatteras NS	Ocracoke	Core Banks	Shackleford Banks	Bogue Banks	Hammocks Beach SP	Camp LeJeune	Topsail Island	Lea Hutaff	Figure 8	Wrightsville Beach	Wrightsville Beach and Fig 8	Masonboro	Carolina Beach/Ft. Fisher	Bald Head Island	Oak Island	Holden Beach	Ocean Isle Beach	Sunset Beach	Brunswick County	Year Totals
1987			5474	1409	58	0	0		0					0								3337	**10278**
1988			2518	13310	900	2	0		0					0								3531	**20261**
1989					0	0	0		0					0								0	**0**
1990			3082	250	339	175	0		0					0								613	**4459**
1991					0	0	467	703	0					0					0	0		0	**1170**
1992					0	10	2556	407	0	22410			416	0	2	9	1	3148	21	5		3175	**32160**
1993					1290	975	3762	73	0	2089		1344	157	0	7	35	26	6103	52	15		6286	**22214**
1994			0	0	704	948	1181	3	0	135		1309	38	0	19	103	2	4409	239	112		4762	**13964**
1995			0	1	75	1155	14776		0	1925		3965	1323	0	295	579	1	4628	59	22		4710	**33514**
1996			88	10	1	3	0		0	1000		995	289	0		93	37	1983	99	819		3038	**8455**
1997			65	6	2	51	81		0	3			22	0		1	0	599	1	7		607	**1445**
1998			265	0	125	369	3946	1000	0	110			191	0	231	1	107	5367	32	11		0	**11755**
1999			8	0	2	9	218	1	0	39			1	0	6	0	24	15	268	5		0	**596**
2000			2	0	4	13	40		0	12			5	0	3		3	9	10	4			**105**
2001			43	8	51	126	451		0	4041			64	0	9		1	66	223	5			**5088**
2002			86	7	71	261	1983	50	0	413			104	72	51		0	542	702	45			**4387**
2003			19	11	206	1354	5270	66	0	1043			735	3	207		0	1267	843	206			**11230**
2004			1	0	79	58	5292	22	1797	1722			782	656	664	2	0	11	79	49			**11214**
2005			1	1	284	671	10711		1302	3416	1011		244	772	0	1	45	174	800	545			**19978**
2006			0	0	33	30	251	2		16	39			4		1	4	462	1954	337	118		**3251**
2007			0	0	2	125	130	6	5	160	21	0	9		0	0	0	116	281	20			**875**
2008		0	0	0	0	76	313		17	432	14	0	3		0	0	2	65	574	110			**1606**
2009		0	0	0	1	100	281	71	15	80	6	0	0		0	0	8	64	123	36			**785**
2010		0	0	0	6	28	70	187	32	215	18	4	0		0	0	0	1576	434	4			**2574**
2011		0	0	0	1	18	56	0	6	136	0	17	2		0	0	0	16	116	5			**373**
2012		0	0	0	0	7	5	1	4	83	2	0	0		NS	0	NS	5	46	1			**154**
2013		0	0	0	0	0	1	0	1	10	1	31	0		0	0	NS	1	108	1	12		**166**
2014					0	0	52	0	27	38	3		0		0	0	0	1	349	20	36		**526**
Site Totals	**0**	**0**	**11652**	**15013**	**4234**	**6564**	**51893**	**2592**	**3206**	**39528**	**1115**	**7665**	**4385**	**1507**	**1494**	**825**	**261**	**30627**	**7413**	**2384**	**166**	**30059**	**222583**
																							222583

Table 8-2. BOs issued since 2014 within the Raleigh Field Office geographic area for seabeach amaranth.

OPINIONS	SEABEACH AMARANTH HABITAT
Fiscal Year 2014: 1 BO	12,600 lf (2.4 mi)
Fiscal Year 2015: 4 BOs	67,968 lf (12.9 mi)
Fiscal Year 2016: 5 BOs	169,250 lf (32.05 mi)
Fiscal Year 2017: 2 BOs including Statewide Programmatic	27,650 lf (5.24 mi) plus up to 25 mi/62.5 mi per year
Fiscal Year 2018 (to date): 1 BO	23,000 lf (4.36 mi)
Total: 13 BOs	**300,468 lf (56.9 mi)** **plus up to 25/62.5 mi per year**

8.3. Effects of the Action on Seabeach Amaranth

This section analyzes the direct and indirect effects of the Action on seabeach amaranth, which includes the direct and indirect effects of interrelated and interdependent actions. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Because suitable habitat for seabeach amaranth includes upland habitats along lower foredunes, upper beach strands and overwash flats, dredging is not expected to effect seabeach amaranth or its habitat and will not be discussed further.

8.3.1. Effects of Sand Placement on Seabeach Amaranth

The proposed action has the potential to adversely affect seabeach amaranth and its habitat. 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 place sand between November 16 and March 31. These time periods may include the growing season of seabeach amaranth.

Applicable Science and Response Pathways and Interpretation of Effects

Placement of sand will occur within and adjacent to seabeach amaranth habitat along 24,000 lf of oceanfront shoreline. 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. The timing of project construction could directly and indirectly impact seabeach amaranth. The construction window will extend into the seabeach amaranth growing season. The effects of the project construction include burying, trampling, or injuring plants as a result of construction operations and/or sediment disposal activities; and burying seeds to a depth that would prevent future germination as a result of construction operations and/or sediment disposal activities. Direct effects would be expected to be short-term in duration.

Indirect effects include destruction of plants by trampling or breaking as a result of increased recreational activities. Future tilling or removal of incompatible material on the beach may be necessary if sediment quality hinders sea turtle nesting activities. The placement of heavy machinery or associated tilling equipment on the beach may destroy or bury existing plants.

However, the placement of 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 sand may be compatible with seabeach amaranth provided the material placed on the beach is compatible with the natural sand.

8.4. Cumulative Effects on Seabeach Amaranth

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. Potential cumulative effects are unknown at this time. It is reasonable to expect continued dredging, 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.

8.5. Conclusion for Seabeach Amaranth

In this section, we summarize and interpret the findings of the previous sections for seabeach amaranth (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"Jeopardize the continued existence" 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 (50 CFR §402.02).

Status

The Service has determined that seabeach amaranth is threatened due to its vulnerability to human and natural impacts and the fact that it had been eliminated from two-thirds of its historic range (USFWS 1996b).

Baseline

Within the Action Area, seabeach amaranth numbers have been very high in the past; in the thousands of individuals on Topsail Island in the 1990s and early 2000s. Over the past 10-20 years, the numbers of seabeach amaranth plants has plummeted, with 10 plants reported in 2013 and 38 reported in 2014 along the entire Topsail Island shoreline.

Effects

The proposed placement of sand on 24,000 lf of beach will occur within seabeach amaranth habitat. The placement of sand in the Action Area could bury existing plants and also bury seeds to a depth that would prevent germination. Increased traffic from recreationists, their vehicles, and their pets can also destroy existing plants by trampling or breaking the plants. It is unclear whether the placement of sand would have positive impacts on seabeach amaranth by creating additional habitat for the species, or by exposing seeds that had previously been buried.

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of seabeach amaranth.

9. INCIDENTAL TAKE STATEMENT

ESA §9(a)(1) and regulations issued under §4(d) prohibit the take of endangered and threatened fish and wildlife species without special exemption. The term "take" in the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (ESA §3). In regulations at 50 CFR §17.3, the Service further defines:

- "harass" as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering;"

- "harm" as "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering;" and
- "incidental take" as "any taking otherwise prohibited, if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."

Under the terms of ESA §7(b)(4) and §7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered prohibited, provided that such taking is in compliance with the T&Cs of an ITS.

This BO evaluated effects of the Action on the threatened seabeach amaranth. ESA §7(b)(4) and §7(o)(2), which provide the authority for issuing an ITS, do not apply to listed plant species. However, ESA §9(a)(2) prohibits certain acts with respect to endangered plant species, including:

(a) remove and reduce to possession from areas under Federal jurisdiction;
(b) maliciously damage or destroy on areas under Federal jurisdiction; and
(c) remove, cut, dig up, or damage or destroy on any other area in knowing violation of any law or regulation of any State or in the course of any violation of a State criminal trespass law.

Regulations issued under ESA §4(d) extend the prohibition under (a) above to threatened plant species (50 CFR §17.71). The damage or destruction of endangered and threatened plants that is incidental to (not the purpose of) an otherwise lawful activity is not prohibited.

This BO evaluated effects of the Action on loggerhead, green, and Kemp's ridley sea turtles, piping plover, and red knot, and determined that incidental take of these species is reasonably certain to occur. The Service will not refer the incidental take of piping plover and red knot for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 703-712), if such take is in compliance with the T&Cs specified below.

For the exemption in ESA §7(o)(2) to apply to the Action considered in this BO, the Corps must undertake the non-discretionary measures described in this ITS, and these measures must become binding conditions of any permit, contract, or grant issued for implementing the Action. The Corps has a continuing duty to regulate the activity covered by this ITS. The protective coverage of §7(o)(2) may lapse if the Corps fails to:

- assume and implement the T&Cs; or
- require a permittee, contractor, or grantee to adhere to the T&Cs of the ITS through enforceable terms that are added to the permit, contract, or grant document.

In order to monitor the impact of incidental take, the Corps must report the progress of the Action and its impact on the species to the Service as specified in this ITS.

9.1. Amount or Extent of Take

This section specifies the amount or extent of take of listed wildlife species that the Action is reasonably certain to cause, which we estimated in the "Effects of the Action" section(s) of this BO. We reference, but do not repeat, these analyses here. We do not anticipate take for seabeach amaranth, since the ESA does not prohibit incidental take of listed plants.

9.1.1. Sea Turtles

The Service anticipates that the Action is reasonably certain to cause incidental take of individual sea turtles consistent with the definition of harass resulting from changes to the behavior of adult female sea turtles; berm slope, escarpment formation, and sediment quality effects on the ability of the females sea turtles to access high quality nesting habitat; and wasted energy caused by increased numbers of false crawls (see **Section 3.3.1**). The Service anticipates that the Action is reasonably certain to cause incidental take of individual eggs and hatchling sea turtles consistent with the definition of harm resulting from reduced hatching and emerging success; changes to incubation conditions within the nest; an increase in the number of nests placed in areas that may wash out; and injury or death due of hatchlings due to deterrence or misdirection from artificial lighting (see **Section 3.3.1**).

For this and other sand placement BOs, the Service typically uses a surrogate to estimate the extent of take. The amount of take is directly proportional to the spatial/temporal extent of occupied habitat that the Action affects, and exceeding this extent would represent a taking that is not anticipated in this BO. 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, nest mark and avoidance, or egg relocation program (2) the total number of hatchlings per undiscovered nest is unknown; (3) the reduction in percent hatching and emerging success per relocated nest over the natural nest site is unknown; (4) an unknown number of females may avoid the project beach and be forced to nest in a less than optimal area; (5) lights may misdirect an unknown number of hatchlings and cause death; and (6) escarpments may form and 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 sand placement activities on suitable turtle nesting beach habitat because: (1) turtles nest within the Action Area; (2) the nourishment project will modify the incubation substrate, beach slope, and sand compaction; and (3) artificial lighting will deter and/or misdirect nesting hatchling turtles.

Anticipated Take of Loggerhead, Green, and Kemp's Ridley Sea Turtles

Amount or Extent	Life Stage	Form of Take
24,000 lf suitable breeding	Adults	Harass
24,000 lf suitable breeding habitat (shoreline)	Eggs and Hatchlings	Harm

Due to the difficulty of detecting take of nesting sea turtles and sea turtle nests caused by the Action, the Corps will monitor the extent of taking using the surrogate measure specified in the table above, and also monitor sea turtle nesting in the project area. Instructions for monitoring and reporting take are provided in **Section 9.4**.

9.1.2. Piping Plover

The Service anticipates that the Action is reasonably certain to cause incidental take of individual piping plovers consistent with the definition of harass resulting from 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 (See **Section 5.3.2**).

The Service anticipates that the Action is reasonably certain to cause incidental take of individual piping plovers consistent with the definition of harm resulting from direct loss of optimal foraging and roosting habitat in the critical habitat unit (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 piping plover); burial, crushing, and suffocation of invertebrate prey species; delayed recovery of the benthic prey base or changes in their communities due to physical habitat changes; increased predation from avian and mammalian predators attracted to the Action Area by food waste; morphological changes to adjacent piping plover habitat that increase disturbance to the species and/ or decrease survival; a decrease in the creation of optimal foraging and roosting habitat; and an increase the attractiveness of these beaches for recreation increasing recreational pressures. These effects are also mirrored for the nesting habitat and would reasonably cause incidental take of eggs and hatchlings. See **Section 5.3.2**.

For this and other sand placement BOs, the Service typically uses a surrogate to estimate the extent of take of piping plovers. The amount of take is directly proportional to the spatial/temporal extent of occupied habitat that the Action affects, and exceeding this extent would represent a taking that is not anticipated in this BO. It is difficult for the Service to estimate the exact number of piping plovers that could be breeding, migrating through, or wintering within the Action Area at any point in time and place during and after project construction. Disturbance to suitable habitat resulting from placement of sand would affect the ability of an undetermined number of piping plovers to find suitable foraging and roosting habitat during construction and for an unknown length of time after construction.

The Service anticipates that directly and indirectly an unspecified amount of piping plovers along 24,000 lf of shoreline and 200 acres of intertidal habitats within New Topsail Inlet

(Critical Habitat Unit NC-11), all at some point, potentially usable by piping plovers, could be taken in the form of harm and harassment as a result of this proposed action. Incidental take of piping plovers 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 may be carried away by waves or predators.

However, the level of take of this species can be anticipated by the proposed activities because:

(1) piping plovers breed, 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 and vehicular disturbance may be expected; and
(4) a temporary reduction of food base will occur.

Anticipated Take of Piping Plover

Amount or Extent	Life Stage	Form of Take
24,000 lf of Shoreline and up to 200 acres of Critical Habitat	Adults	Harass and/or Harm
Approximately 30 acres suitable breeding habitat	Eggs and Hatchlings	Harm

Due to the difficulty of detecting take of piping plover caused by the Action, the Corps will monitor the extent of taking using the surrogate measure specified in the table above, and also monitor piping plover abundance and distribution in the Action Area. Instructions for monitoring and reporting take are provided in **Section 9.4** and the **Appendix**.

9.1.3. Red Knot

The Service anticipates that the Action is reasonably certain to cause incidental take of individual red knots consistent with the definition of harass resulting from 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 (See **Section 7.3.2**).

The Service anticipates that the Action is reasonably certain to cause incidental take of individual red knots consistent with the definition of harm resulting from direct loss of optimal foraging and roosting 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 red knot); burial, crushing, and suffocation of invertebrate prey species; delayed recovery of

the benthic prey base or changes in their communities due to physical habitat changes; increased predation from avian and mammalian predators attracted to the Action Area by food waste; morphological changes to adjacent red knot habitat that increase disturbance to the species and/ or decrease survival; a decrease in the creation of optimal foraging and roosting habitat; and an increase the attractiveness of these beaches for recreation increasing recreational pressures. See **Section 7.3.2**.

For this and other sand placement BOs, the Service typically uses a surrogate to estimate the extent of take for red knots. The amount of take is directly proportional to the spatial/temporal extent of occupied habitat that the Action affects, and exceeding this extent would represent a taking that is not anticipated in this BO. It is difficult for the Service to estimate the exact number of 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 red knots to find suitable foraging and roosting habitat during any given year.

The Service anticipates that directly and indirectly an unspecified amount of red knots along 24,000 lf of shoreline and 200 acres of intertidal habitats within New Topsail Inlet, all at some point, potentially usable by red knots, could be taken in the form of harm and harassment as a result of this proposed action. Incidental take of 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 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) 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 or vehicular disturbance may be expected; and
(4) a temporary reduction of food base will occur.

Anticipated Take of Red Knot

Amount or Extent	Life Stage	Form of Take
24,000 lf of Shoreline and Up to 200 acres of Intertidal Habitat	Adults	Harass and/or Harm

Due to the difficulty of detecting take of red knot caused by the Action, the Corps will monitor the extent of taking using the surrogate measure specified in the table above, and

also monitor piping plover abundance and distribution in the Action Area. Instructions for monitoring and reporting take are provided in **Section 9.4** and the **Appendix**.

9.2. Reasonable and Prudent Measures

The Service believes the following RPMs are necessary or appropriate to minimize the impact of incidental take caused by the Action on listed wildlife species. The RPMs are described for each listed wildlife species in the subsections below.

9.2.1. All Species

1. All sand placement activities above MHW must be conducted within the winter work window (November 16 to March 31).

2. Prior to sand placement, all derelict material, large amounts of rock, or other debris must be removed from the beach to the maximum extent possible.

3. Conservation Measures included in the permit applications/project plans must be implemented in the proposed project. If a RPM and T&C address the same requirement, the requirements of the RPM and T&C take precedence over the Conservation Measure.

4. During construction, trash and food items shall be disposed of properly either in predator-proof receptacles, or in receptacles that are emptied each night to minimize the potential for attracting predators of piping plovers, red knots, and sea turtles.

5. The pipeline route/pipeline placement must be coordinated with NCDCM, the Corps, the Service, and the NCWRC. Pipeline placement coordination may be accomplished through the permit application process.

6. A meeting between representatives of the Applicant and contractor(s), the Corps, the Service, the NCWRC, the permitted sea turtle surveyor(s), and other species surveyors, as appropriate, must be held prior to the commencement of work. Advance notice (of at least 10 business days) must be provided prior to conducting this meeting.

7. Access points for construction vehicles should be as close to the project site as possible. Construction vehicle travel down the beach should be limited to the maximum extent possible.

9.2.2. Piping Plovers and Red Knots

8. All personnel involved in the construction or sand placement process along the beach shall be aware of the potential presence of piping plovers and red knots. Before start

of work each morning, a visual survey must be conducted in the area of work for that day, to determine if piping plovers and red knots are present.

9. If project-related activities will potentially adversely affect nesting shorebirds or active nesting habitat, the Corps or Permittee must coordinate with the Service and NCWRC prior to proceeding. If the project is ongoing and shorebirds begin territorial or other nesting behaviors within the project area, then the Corps or Permittee must contact the Service and NCWRC as soon as possible.

10. The Corps or the Permittee shall clearly delineate work areas within piping plover critical habitat, such as dredge footprint(s), pipeline corridors, travel corridors, and access points. Disturbance within those delineated work areas must be limited to the maximum extent possible, thereby minimizing effects to sandy, sparsely-vegetated habitat within the project footprint.

9.2.3. Loggerhead, Green, and Kemp's Ridley Sea Turtles

11. Only beach quality sand suitable for sea turtle nesting, successful incubation, and hatchling emergence shall be used for sand placement.

12. During dredging operations, material placed on the beach shall be qualitatively inspected daily to ensure compatibility. If the inspection process finds that a significant amount of non-beach compatible material is on or has been placed on the beach, all work shall stop immediately and the NCDCM and the Corps will be notified by the Permittee and/or its contractors to determine the appropriate plan of action.

13. Visual surveys for escarpments along the Action Area must be made immediately after completion of sand placement, and within 30 days prior to May 1, for two subsequent years after any construction or sand placement event.

14. Sand compaction must be qualitatively evaluated at least twice after each sand placement event. Sand compaction must be inspected in the project area immediately after completion of any sand placement event and one time after project completion between October 1 and May 1.

9.3. Terms and Conditions

In order for the exemption from the take prohibitions of §9(a)(1) and of regulations issued under §4(d) of the ESA to apply to the Action, the Corps must comply with the T&Cs of this statement, provided below, which carry out the RPMs described in the previous section. These T&Cs are mandatory. As necessary and appropriate to fulfill this responsibility, the Corps must require any permittee, contractor, or grantee to implement these T&Cs through enforceable terms that are added to the permit, contract, or grant document.

9.3.1. All Species

1. For the life of the permit, all sand placement activities above MHW must be conducted within the winter work window (November 16 to April 30), unless a variance is approved after additional consultation with the Service.

2. Prior to sand placement, all derelict material, large amounts of rock, or other debris must be removed from the beach to the maximum extent possible. If debris removal activities take place during shorebird breeding season (April 1– August 31), the work shall be conducted during daylight hours only.

3. Conservation Measures included in the permit applications/project plans must be implemented in the proposed project. If a RPM and T&C address the same requirement, the requirements of the RPM and T&C take precedence over the Conservation Measure.

4. During construction, trash and food items shall be disposed of properly either in predator-proof receptacles, or in receptacles that are emptied each night to minimize the potential for attracting predators of piping plovers, red knots, and sea turtles.

5. The pipeline route/pipeline placement must be coordinated with NCDCM, the Corps, the Service, and the NCWRC. Pipeline placement coordination may be accomplished through the permit application process.

6. Access points for construction vehicles should be as close to the project site as possible. Construction vehicle travel down the beach should be limited to the maximum extent possible.

7. A meeting between representatives of the contractor(s), the Corps, the Service, the NCWRC, and NCDCM, must be held prior to the commencement of work. Advance notice (of at least 5 business days) must be provided prior to conducting this meeting. The meeting will provide an opportunity for explanation and/or clarification of the Conservation Measures and T&Cs, and will include the following:
    a) Staging locations, and storing of equipment, including fuel stations;
    b) Coordination with the surveyors on required species surveys;
    c) Pipeline placement;
    d) Minimization of driving within and around the Action Area;
    e) Follow up coordination during construction and post construction;
    f) Direction of the work including progression of sand placement along the beach;
    g) Plans for compaction monitoring;
    h) Plans for escarpment surveys and
    i) Names and qualifications of personnel involved in any required species surveys.

9.3.2. Piping Plover and Red Knot

8. All personnel involved in the construction or sand placement process along the beach shall be aware of the potential presence of piping plovers and red knots. Before start of work each morning, a visual survey must be conducted in the area of work for that day, to determine if piping plovers and red knots are present. If shorebirds 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. Construction operations shall be carried out at all times in a manner as to avoid negatively impacting shorebirds and allowing them to exit the area.

9. If project-related activities will potentially adversely affect nesting shorebirds or active nesting habitat, the Corps or Permittee must coordinate with the Service and NCWRC prior to proceeding. If the project is ongoing and shorebirds begin territorial or other nesting behaviors within the project area, then the Corps or Permittee must contact the Service and NCWRC as soon as possible.

10. Piping plover habitat (sandy unvegetated habitat) within the critical habitat unit shall be avoided to the maximum extent practicable when staging equipment, establishing the dredge footprint, travel corridors, and aligning pipeline. The Corps or the Permittee, to the maximum extent practicable, shall clearly delineate work areas within the critical habitat unit such as pipeline corridors, dredge footprint, travel corridors, and access points. Disturbance outside those delineated work areas must be limited, thereby minimizing effects to sandy unvegetated habitat. Driving on the beach for construction shall be limited to the minimum necessary within the designated travel corridor.

9.3.3. Sea Turtles

11. Only beach compatible fill shall 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 comprised 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 most recent version of the North Carolina Technical Standards for Beach Fill (15A NCAC 07H .0312) is considered compatible.

12. During dredging operations, material placed on the beach shall be qualitatively inspected daily to ensure compatibility. If the inspection process finds that a

significant amount of non-beach compatible material is on or has been placed on the beach, all work shall stop immediately, and the NCDCM, Corps, and BOEM (as appropriate) will be notified by the permittee and/or its contractors to determine the appropriate plan of action. Required actions may include immediate removal of material and/or long-term remediation activities.

13. Visual surveys for escarpments along the Action Area must be made immediately after completion of sand placement, 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.

14. Sand compaction must be qualitatively evaluated at least twice after each sand placement event, once in the project area immediately after completion of any sand placement event and once after project completion between October 1 and May 1. Compaction monitoring and remediation are not required if the placed material no longer remains on the beach. Within 14 days of completion of sand placement and prior to any tilling (if needed), a field meeting shall be held with the Service, NCWRC, and the Corps to inspect the project area for compaction and determine whether tilling is needed.
    a) If tilling is needed for sand suitability, the area must be tilled to a depth of 36 inches. All tilling activities shall be completed prior to May 1 of any year.
    b) Tilling must occur landward of the wrack line and avoid all vegetated areas that are 3 square feet or greater, with a 3-foot buffer around all vegetation.
    c) If tilling occurs during the shorebird nesting season or seabeach amaranth growing season (after April 1), shorebird surveys and/or seabeach amaranth surveys are required prior to tilling.
    d) A summary of the compaction assessments and the actions taken shall be included in the annual report to NCDCM, the Corps, and the Service.
    e) These conditions will be evaluated and may be modified if necessary to address and identify sand compaction problems.

9.4. Monitoring and Reporting Requirements

In order to monitor the impacts of incidental take, the Corps must report the progress of the Action and its impact on the species to the Service as specified in the incidental take statement (50 CFR §402.14(i)(3)). This section provides the specific instructions for such monitoring and reporting. As necessary and appropriate to fulfill this responsibility, the Corps must require any permittee, contractor, or grantee to accomplish the monitoring and reporting through enforceable terms that are added to the permit, contract, or grant document. Such enforceable terms must include a requirement to immediately notify the Corps and the Service if the amount or extent of incidental take specified in this ITS is exceeded during Action implementation.

1. Sea turtle nesting surveys must be conducted within the project area between May 1 and November 15 of each year, for at least two consecutive nesting seasons after completion of each sand placement activity (2 years post-construction monitoring after initial construction and each maintenance event). Acquisition of readily available sea turtle nesting data from qualified sources (volunteer organizations, other agencies, etc.) is acceptable. However, in the event that data from other sources cannot be acquired, the Corps or Permittee will be responsible to collect the data. Data collected for each nest should include, at a minimum, the information in the table, below. This information will be provided to the Service's Raleigh Field Office in the annual report, and will be used to periodically assess the cumulative effects of these types of projects on sea turtle nesting and hatchling production and monitor suitability of post construction beaches for nesting. Please see REPORTING REQUIREMENTS below.

Parameter	Measurement	Variable
Number of False Crawls	Visual Assessment of all false crawls	Number/location of false crawls in nourished areas; any interaction of turtles with obstructions, such as sand bags or scarps, should be noted.
Nests	Number	The number of sea turtle nests in nourished areas should be noted. If possible, the location of all sea turtle nests should be marked on a project map, and approximate distance to scarps or sandbags measured in meters. Any abnormal cavity morphologies should be

		reported as well as whether turtle touched sandbags 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

2. A report describing any actions taken must be submitted to the Service's Raleigh Field Office following completion of the proposed work for each year when a sand placement activity has occurred. The report must include the following information:
   g) Project location (latitude and longitude);
   h) Project description (linear feet of beach, actual fill template, access points, and borrow areas);
   i) Dates of actual construction activities;
   j) Names and qualifications of personnel involved in sea turtle nesting surveys and relocation activities(separate the nesting surveys for nourished and non-nourished areas);
   k) Descriptions and locations of self-release beach sites; and
   l) Sand compaction, escarpment formation, and lighting survey results.

3. Seabeach amaranth surveys must be conducted within the entire oceanfront sand placement area (up to 24,000 lf) for a minimum of three years after completion of construction and each maintenance event. At a minimum, the stretches of oceanfront where sand placement occurred should be surveyed. Surveys should be conducted in August or September 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.

4. Two full years of post-construction monitoring is required for piping plovers and red knots. The piping plover and red knot survey protocol in the **Appendix (page 176)** must be followed.

Information required in the above T&C and/or these Reporting Requirements should be submitted to the following address by February 28 of each year a report is due:

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's 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.

Jason Keith
U.S. Fish and Wildlife Service
551-F Pylon Drive
Raleigh, NC 27606
919-856-4786, extension 34

10.CONSERVATION RECOMMENDATIONS

§7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to avoid or minimize the adverse effects of a proposed action, implement recovery plans, or develop information that is useful for the conservation of listed species. The Service offers the following recommendations that are relevant to the listed species addressed in this BO and that we believe are consistent with the authorities of the Corps.

For the benefit of piping plovers, red knots, and sea turtles the Service recommends the following conservation recommendations:

1. The Applicant or the Corps should maintain suitable piping plover 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.

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 species' life history and basic biology and ways recreationists can assist

in species protection efforts (e.g., keeping pets on a leash, removing trash to sealed refuse containers, turning off lights at night, etc.). The Service would be willing to assist the Corps or the Permittee 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.).

3. If public driving is allowed on the project beach, and if the Corps has the authority, we recommend it exercise its discretionary authority to require the Permittee to have authorization from the Service for incidental take of piping plover, red knot, sea turtles, including nests and hatchlings (as appropriate), due to such driving or provide written documentation from the Service that no incidental take authorization is required. If required, the incidental take authorization for driving on the beach should be obtained prior to any subsequent sand placement events.

4. If the Corps has the authority, we recommend it exercise its discretionary authority to require that leash-laws and predator control programs be implemented.

5. The Corps should aid the Service in our efforts to initiate new monitoring efforts and develop a full life-cycle demographic model to explore effects of variation in productivity, annual survival rates, dispersal rates, and carrying capacity of habitat on population viability of the piping plover's three distinct populations.

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.

11.REINITIATION NOTICE

Formal consultation for the Action considered in this BO is concluded. Reinitiating consultation is required if the Corps retains discretionary involvement or control over the Action (or is authorized by law) when:

a. the amount or extent of incidental take is exceeded;
b. new information reveals that the Action may affect listed species or designated critical habitat in a manner or to an extent not considered in this BO;
c. the Action is modified in a manner that causes effects to listed species or designated critical habitat not considered in this BO; or
d. a new species is listed or critical habitat designated that the Action may affect.

In instances where the amount or extent of incidental take is exceeded, the Corps is required to immediately request a reinitiation of formal consultation.

APPENDIX: USFWS Raleigh North Carolina Field Office Piping Plover and Red Knot Survey Minimum Survey Requirements to Document Site Abundance and Distribution

Required skills, training, and equipment for conducting surveys

1. Piping plover monitors must be capable of detecting and recording locations of roosting and foraging plovers, accurately reading and recording bands, and documenting observations in legible, complete field notes. Aptitude for monitoring includes keen powers of observation, familiarity with avian biology and behavior, experience observing birds or other wildlife for sustained periods, tolerance for adverse weather, experience in data collection and management, and patience. Monitors must also be able to captain a boat (if applicable) and walk long distances carrying field gear.

2. Binoculars, a GPS unit (set to record in decimal degrees in the WGS datum), a 10-60x spotting scope with a tripod, boat access (if applicable), and the RFO's datasheet must be used to conduct the surveys.

Piping plover survey methodology

3. Nonbreeding piping plover abundance and distribution must be determined through 6 surveys per season (2 during fall migration scheduled ≤3 days apart, 2 during winter scheduled ≤3 days apart, and 2 during spring migration scheduled ≤3 days apart). Suitable habitat must be surveyed by walking the survey area (weather and tide permitting, no surveys should be conducted if sustained winds exceed 20 mph) during the survey window (July 15 – May 15).

4. Surveys should be scheduled around the peak of migration (September in Fall and March in Spring) based on input from the RFO. Winter surveys must be conducted between December 1 and January 31. Surveys should be conducted around mid-tide when birds will still be foraging, making legs easier to see for re-sighting bands, but more concentrated.

5. All unbanded and banded piping plovers must be recorded on the RFO datasheet. Weather data must be collected at the beginning of each survey. The presence/absence of bands, GPS coordinate, plumage, behavior, and habitat type must be recorded for each piping plover.

6. Band resightings must be read and documented during each survey.

7. GPS coordinates must be collected in decimal degrees during each survey for each bird as close to the location of the bird as possible without causing a change in behavior (if the bird is spending most of its time watching the monitor instead of continuing the behavior it was exhibiting when it was first spotted).

8. Recreation and disturbance must be documented during the surveys. The number of people, dogs (on and off leash), bicycles, vehicles, etc. must be recorded during the surveys. Additionally, any activity causing a disturbance (change in behavior, particularly if the disturbance flushes the birds) to roosting or foraging birds must be noted on the datasheet.

9. Survey data must be recorded in the field on the RFO datasheet and transcribed into the Microsoft Access database (provided by the RFO). Electronic hard copies of the datasheets and the database must be provided annually by June 15 to the RFO.

Red Knot

10. Red knots must be recorded during the piping plover surveys when both species are present. Additional surveys for red knots during their peak season must follow the same protocol outlined above. Band combinations, flag color and alphanumeric codes, and geolocators must be noted on the datasheet if applicable. All resightings must be reported on www.bandedbirds.org.

How To Resight and Report Banded Piping Plovers

Be careful not to disturb the bird. A slow, quiet approach avoids harassment and allows the observer to carefully scan the band combination. Using a spotting scope facilitates accurate observations from a distance.

Please record:

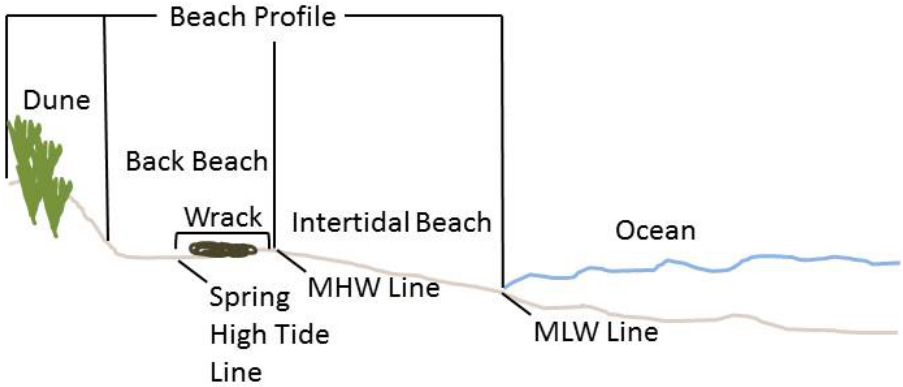
1. Location where the bird was seen (GPS coordinates are helpful).
2. Date when the bird was seen.
3. Any observations of the bird's behavior (e.g., roosting, foraging).
4. Band combination:
    a. Band combinations should be recorded in the following sequence: upper left (UL; above the "knee"), lower left (LL; below the "knee"), upper right (UR), lower right (LR). "Right" and "left" are from the bird's perspective, not the observer's (just like a person's right and left legs). (please refer to http://www.fws.gov/charleston/pdf/PIPL/20141205_usfws_pipl_survey_datasheet.pdf)
    b. Band types include flags (band with tab sticking out), metal, and color bands.
    c. Some bands may have alpha-numeric codes printed on the band or the flag (e.g., A1). The code, in addition to the color and location of the band or flag should be documented. Both the color of the band and the code (e.g., white writing on a green band) should be noted.
    d. Some bands are split (a single band with two colors; e.g., orange/blue) or triple split (a single band with three colors; e.g., blue/orange/blue).
    e. Sometimes two bands of the same color are placed over each other, appearing like one very tall band.
    f. Some piping plovers are banded on the upper legs only, and bands can be stacked (one above the other) on the upper leg.
    g. Record leg positions where bands are absent.
    h. Note if the color or type of any of the bands is uncertain or if some parts of a leg were not seen clearly.
    i. Recognize that band colors can fade over time.

For banded piping plovers seen in North Carolina, please send this information along with the observer's contact information to melissa_chaplain@fws.gov. For more information about band resighting, please consult http://www.fws.gov/charleston/pdf/PIPL_Band_Identification_Training.pdf

Left Figure: This band combination would be recorded as: metal (UL), dark blue (LL), black flag (UR), red over black (LR). The band combination would be recorded as: X,B:Lf,RL. **Middle Figure:** Examples of alpha-numeric gray, black, and white flags. **Right Figure:** Example in yellow circle shows use of an alpha-numeric code on a color band.

Datasheet Habitat Descriptor Definitions

Back beach – dry sand, beach landward of the mean high water (MHW) line and seaward of the dune line.
Dune – A mound, hill, or ridge of wind-blown sand, either bare or covered with vegetation located landward of the back beach.
Ephemeral pool – a temporary water feature located on the beach.
Mudflat – intertidal area typically located behind sand spits adjacent to inlets. They appear darker in color than sand, and are soft and slick to walk on. The closest vegetation is typically *Spartina* sp.
Intertidal beach – wet, smooth sand; beach seaward of the MHW line and landward of the mean low water (MLW) line.
Sandflat – flat, rippled intertidal area along sound shorelines or around the mouth of an inlet. They are firm to walk on.
Dense vegetation – vegetation located on the back beach or dunes that provides >75% cover.
Washover – beach sand that has been transported landward of the beach/dune system by storm waves, areas where sand and shells become the top layer of once vegetated areas following a storm event.
Wrack – organic plant material deposited between MHW line and the spring high tide line.



Nonbreeding PIPL/REKN Survey Data Sheet **Page___of___**

Date:_____**Location**: _____**Observer(s)**: _____

Survey #:_____**Survey Coverage**: (circle one): ALL NE SW **Survey Type**: (circle one): Population Foraging Roosting S/R

Start Time:_____ **End Time**:_____ **General weather** (circle one): Sunny Partly cloudy Cloudy Rain Fog Other (describe)

Temp:____°F **Wind Direction** (circle one): N NE E SE S SW W NW **Wind Speed** (circle one): 0-5 6-10 11-15 16-20 >21 MPH

Tidal stage at start of survey (circle one): Low Mid High (Rising/Falling)

Disturbance (#): Pedestrian(s)_____Boat(s)_____Bicycle(s)_____ATV(s)_____ORV(s)_____Dog(s) On_____Dog(s) Off_____

PIPL/REKN #	ULU	ULL	LLU	LLL	URU	URL	LRU	LRL	Flag or band Code	Latitude	Longitude	Plumage	Behavior	Habitat	Notes

Abbreviation Key							
Band Color		**Plumage**		**Behavior**		**Habitat**	
A	Gray	B	Basic (nonbreeding)	D	Disturbed	M	Mudflats
B	Dark blue	A	Alternate (breeding)	FR	Foraging	S	Sandflats
b	Light blue	P	Partial (some breeding)	R	Roosting	B	Beach
f	Flag			L	Loafing	D	Dunes
G	Dark green			T	Territorial	WR	Wrack
g	Light green			O	Other	IT	Ocean intertidal
L	Black					WA	Washover
N	No band seen (leg position not visible)					VS	Vegetation sparse (<75%)
O	Orange					VT	Vegetation thick (>75%)
P	Pink					EP	Ephemeral pool
R	Red					O	Other
U	Purple						
W	White						
X	Metal						
Y	Yellow						
-	No band (no band on that leg position)						
/	Split band (color/color on one band)						
//	Triple split band (color/color/color on one band)						

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